EyeLink® Data Viewer
User's Manual

Document Version 1.8.402

Please report all functionality comments and bugs to:

support@sr-research.com

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1 Introduction

The EyeLink Data Viewer is a tool that allows the display, filtering, and report output of EyeLink I and EyeLink II EDF data files. The Data Viewer includes the following areas of functionality.

1.1 Data Visualization

The EyeLink Data Viewer supports three trial-based viewing modes: the Spatial Overlay View, the Temporal Graph View, and the Animation View. In the first two viewing modes, the user can specify which event types to display, including fixations, saccades, blinks, messages, and buttons. Sample traces can also be displayed. The animation viewing mode plays back the gaze data of a selected trial.

The Spatial Overlay View allows a trial to be viewed superimposed on the background image that the participant was looking at while the data was being recorded. This view is ideal for relatively static trial presentations, like reading or visual search paradigms. Fixations can be displayed as either circles or as a scan path. Saccades can be displayed as lines with an arrow specifying the saccade direction. Blinks can be displayed as a line joining the last valid sample position prior to the blink and the first valid sample following the blink. Message and button events can be displayed as a small rectangle, where the position of the event is determined by the position of the nearest sample recorded at the message or button time.

The Temporal Graph View provides a two dimensional plot of trial data. The X axis represents time, while the Y axis represents the location of the samples or events being plotted. This view is suitable for a wide range of experimental paradigms, including those using dynamic trial displays. The scale of the graph can be changed via zoom in and zoom out operations. This view supports binocular display of sample position and pupil size traces.

The color of individual events, as well as the global color of a given event type or sample trace, can be changed as desired. There is a vast number of preferences that can be configured by the user, saved, and then applied to future loaded data.

The Animation View plays back the subject's gaze data in a trial, with a concurrent time code displaying the time from the start of trial recording. If the image that was shown during the trial recording is available, it can be loaded as the background for the playback view. A trackbar control displays the progress of the playback and lets the user select a specific position to start playback. The speed of playback can also be adjusted.

Multiple viewing windows can be opened at one time, displaying data from different trials or displaying data of one single trial in the Spatial Overlay View, Temporal Graph View, and Animation View concurrently.

1.2 Event Selection

EyeLink events can be selected for either of the data views (temporal graph view or spatial overlay view). Detailed properties of the selected event can be examined within a Inspector Window that also provides a list view of all visible events in the selected trial. Properties of a selected event that are editable by the user (like the events color) can be modified directly within the inspector window.

1.3 Interest Area Definition

The Spatial Overlay View allows creation of any number of interest areas for the trial. Rectangular, elliptic, and freehand interest area shapes can be created. The position and shape of the Interest Area can be modified after Interest Area creation.

Users can view fixation-based statistics for a selected interest area, including the fixation count and total dwell time for the interest area, as well as the proportion of fixations and dwell time relative to the trial totals.

Interest area templates can be created which can then be applied to multiple trials, speeding the process of defining interest areas for multiple trials.

1.4 Event Filtering

The EyeLink Data Viewer supports data filtering, including deleting, merging, and drift correcting event types. Not all filtering functions are available to all event types. The original EyeLink EDF file is never modified by the Data Viewer, so the originally recorded data is always available.

Any event can be hidden within the Data Viewer either manually or through the definition of some spatial or temporal filtering preferences. Hiding events allows the user to focus on a subset of a trial's data. Hidden events can be made visible again at a later date if required.

Events can also be deleted from within the Data Viewer. This is useful, for example, if the researcher inspects a specific fixation or saccade event and determines that the event detection performed by the EyeLink on-line parser did not satisfy their needs. If a fixation or saccade event is deleted, the surrounding saccade or fixation events are automatically merged to keep the event structure consistent.

The position of a fixation event can also be adjusted if required. This is only suggested if it is obvious to the user that improper system setup or calibration has resulted in a trial's fixation data containing significant drift that can be easily corrected manually. Any event that is adjusted in this fashion is flagged so that it is clear what events have been manually altered. Optionally, if the position of a fixation is adjusted, the adjoining

saccade end point and start point are also adjusted so that the saccade positions are kept consistent with fixation positions.

1.5 Interest Periods and Reaction Time Definition

For each trial, the user may selectively view and perform analysis on data within a specific period of time within a trial (Interest Period). The EyeLink Data Viewer allows the user to create interest periods based on messages and button events. The created interest periods are added to the interest period list. The user can navigate between different interest periods by selecting the desired interest period from the list. For each interest period, only those events falling within that period are shown in the spatial overlay, temporal graph views, and in the event list of the inspector window. In addition, only those events and data within the selected interest period (custom-defined interest period, or the default – "Full Trial Period") are exported to the output file.

One important variant of the interest period is the reaction-time period. Reaction Time Definitions (RTD) can be created and applied to all trials loaded into an EyeLink Data Viewer session. Each RTD can have a set of trial condition variables that must be matched for the RTD to be applied to a given trial. The message event to use as the start time for the reaction time can be defined. Each RTD can have a fixation, saccade, button, or message event as the ending event for the reaction time calculation. Depending on the event type selected for the reaction time end event, a set of event properties can be specified to determine which event should be used within each trial. A number of RTDs can be created for a given Data Viewer session, allowing multiple reaction time conditions to be specified. Each trial will only be matched to at most one RTD.

1.6 Data Output and Analysis

Both Spatial Overlay and Temporal Graph trial views can be saved as JPEG images for illustrative purposes.

A series of output reports can be run for a Data Viewer session.

The Fixation Output Report generates one row for each visible fixation within the Data Viewer. A set of output variables can be selected, with each variable output as a column in the report. Fixation report variables include start and end time, duration, average position, interest area identifier, etc. A set of relative variables is also available, including the previous and next fixations position, angle, distance, and direction.

The Saccade Output Report generates one row for each visible saccade within the Data Viewer. A set of output variables can be selected, with each variable output as a column in the report. Saccade output report variables include start and end time, start and end position, amplitude, angle, direction, average and peak velocity, etc. A set of relative variables is also available, including the previous and next saccades start and end position, etc.

The Interest Area Output Report generates one row for each interest area in every trial loaded in the Data Viewer. Variables include the interest area identifier, label, fixation index list, number fixations, summed dwell time, and proportions of fixations and dwell time in the interest area relative to the trial.

The Trial Output Report generates one row of data for each trial within the Data Viewer. Variables include the count of each event type visible within the trial, the average fixation duration and saccadic amplitude, as well as the reaction time calculated for the trial based on the reaction time definitions created for the Data Viewer session.

The Sample Output Report provides a columnar output of eye movement data for each eye sample in a trial. Variables include the index of the sample in a trial, time of the sample, position (x, y), velocity, acceleration, and pupil data of the current sample. If appropriate target position messages are read from the EDF file, the position, velocity, and acceleration data of the targets (up to two targets) can also be provided.

The user can also save the spatial overlay and temporal graph views into image files, save the playback of the trial into a movie file, or create a "landscape" view (i.e., fixation map) for a trial or for a group of trials with the same background image.

1.7 Experiment Integration

The EyeLink Data Viewer allows commands to be inserted directly into the EyeLink EDF file when an experiment is running. This allows the experiment to be significantly integrated into the Data Viewer. These commands are interpreted by the Data Viewer when the data file is loaded and automates several areas of the viewer functionality.

By using a set of predefined viewer commands, the programmer of an experiment can inform the Data Viewer regarding:

a) The image(s) to load for each trial's Spatial Overlay View.
b) The Interest Areas to load for each trial.
c) The Reaction Time Definitions to apply to the Data Viewing session.
d) The trial condition variables and values to use for each trial.
e) The position of the target in a dynamic display.

2 Installation

2.1 System Requirements

Operating System: Windows 98, NT, 2000, or XP

Processor: PIII 800 MHz or better processor

RAM: minimum 256 MB RAM (512 MB recommended)

Disk Space: 50 MB free disk space for application plus space required for EyeLink data files and saved viewing sessions.

Monitor Resolution: 1024x768 or better resolution (1600 x 1200 recommended)

Other: Free USB port required

2.2 Setup

1) Install EyeLink Data Viewer by running the installer program (EyeLinkDV*.exe). The latest version of the installer program can be downloaded from https://www.sr-support.com/forums/showthread.php?t=10.

2) Install the standalone HASP key driver (if this is the first time that the USB dongle have been used on the display PC). You may install the driver by clicking "Start -> All Programs -> SR Research -> Install HASP Driver" from your computer desktop or double clicking on "hdd32.exe" in "C:\Program Files\SR Research\Common" folder.

3) Before starting the application, be sure to plug the license key to a USB port of the computer.

4) From the computer desktop, click "Start -> All Programs -> SR Research -> EyeLink -> Data Viewer -> DataViewer" to run the application.

Important: A USB Dongle provided by SR Research is required to run this application and must remain connected to the PC while the application is running. If a USB Dongle is not detected by the program, the application will run in a DEMO mode supporting limited data loading.

3 Working with Files

The EyeLink Data Viewer can import EyeLink EDF files. The viewer loads each data file into a Data Viewing Session (DVS). A DVS can consist of many EyeLink data files. Only one DVS can be open within the Data Viewer at a time.

Once a DVS has been created and EyeLink data files have been imported into it, the DVS file can be saved and then reloaded at a later date for future analysis. It is *much* quicker to load a DVS than to load the original EDF files of which the DVS consists.

All changes made during an viewing session only affect the DVS data; the original EDF files are never altered.

3.1 Creating a Data Viewing Session (DVS)

From the menu, choose:

File → New

Tip: A new viewing session can also be created by clicking the Create New Viewing Session tool on the standard toolbar, or press Ctrl+N.

Tip: To find out the meaning of a tool on the standard toolbar, simply place the mouse over the tool.

3.2 Opening an Existing Viewing Session

To open an existing viewing session

1) From the menus, choose:
   File → Open
2) In the Open dialog box, browse to the location of the file and select it.
3) Click Open

Tip: A saved viewing session can also be opened by clicking the Open Existing Viewer Session tool on the standard toolbar, or press Ctrl+O.

3.3 Saving a Viewing Session

From the menus, choose:

File → Save

Tip: The viewing session can also be saved by clicking the Save Viewing Session tool on the standard toolbar, or press Ctrl+S.

3.4 Saving an Existing Viewing Session to a Different File

To save a viewing session to a file

1) From the menus, choose:
   File → Save AS
2) In the Save As dialog box, browse to the directory in which you want to save the document.
3) In the File name text box, type in the name for the document.
4) Click Save.

Tip: The viewing session can also be saved by clicking the Save Viewing Session As tool on the standard toolbar.

3.5 Importing an EyeLink Data File

EyeLink EDF files can be imported into an already opened Viewing session or, if no Viewing session is open, a new one will be created for you when the data files are imported.

To import an .EDF file,

1) From the menus, choose:
   File → Import Data → EyeLink File(s)
2) In the Load dialog box, browse to the location of the EDF file that you want to import and select it.
3) Click Load.

Tip: EyeLink data can also be imported by clicking the Import EyeLink Data File button on the standard toolbar, or press Ctrl+I.

Note: The time it takes to load the data files will depend on their size and heavily on whether or not you are loading samples from the data file. A 60 minute, binocular, 500Hz recording will take 3 – 4 minutes to initially parse the data file if loading all events and samples. Once you have saved the viewing session, reloading the session takes a fraction of the time because the data is in a format optimized for the Data Viewer.

Note: To load data files using the SceneLink gaze mapping, please make sure to enable the "Enable SceneLink Gaze Mapping" and "Generate SceneLink Frame Messages" in the "Data Loading" preferences settings before you import the data files. Make sure that you have already created the lookup tables for the trials in SceneLink.

4 Data Viewer Windows

The EyeLink Data Viewer uses a desktop framework that contains all windows of the Viewer application. Once a Data Viewing Session (DVS) is opened and EyeLink data is loaded, two windows will appear: the Inspector Window on the left and the Trial View Window on the right. The Inspector Window enables the user to choose data to be viewed, to review statistical summaries, and to configure default application settings. The Trial View window allows a graphic examination of the data of the selected trial. Both windows can be minimized and maximized within the Application desktop. The figure below shows the viewer desktop after loading the sample picture.edf file.

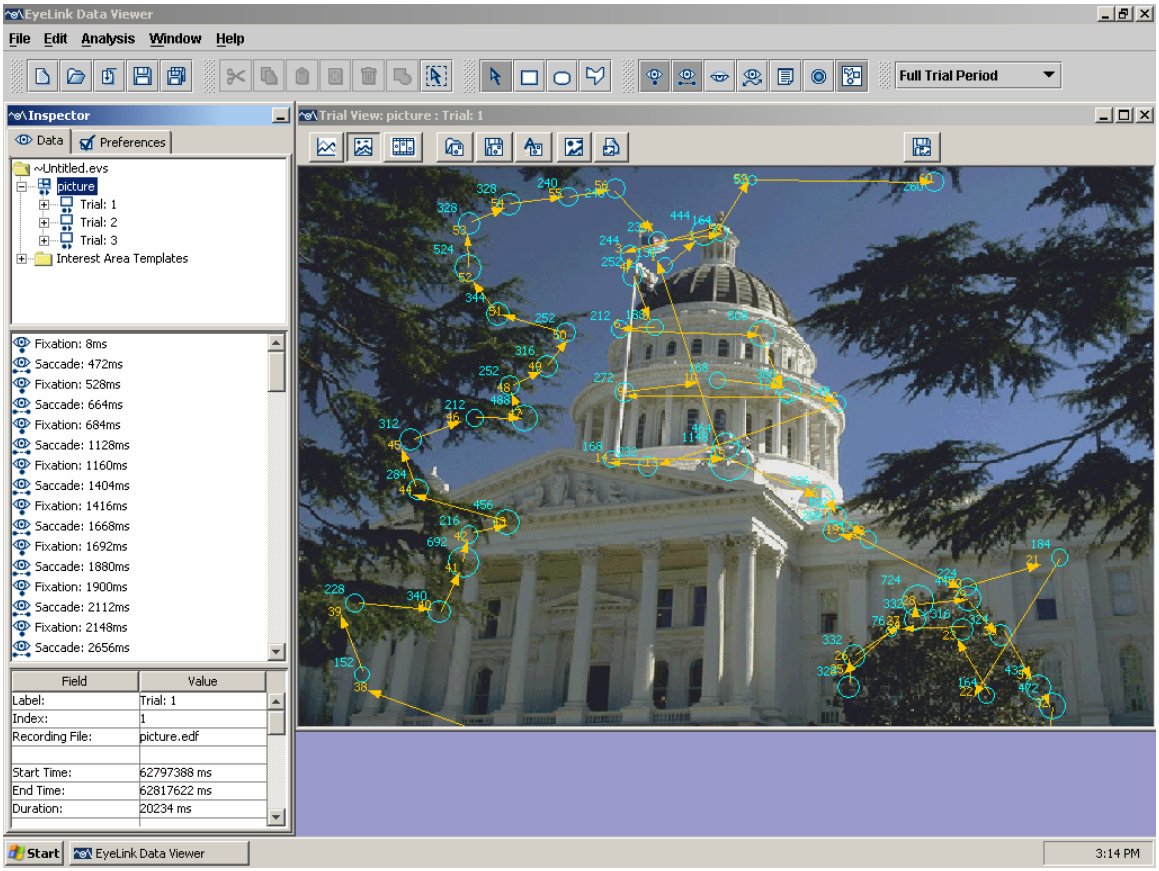


Figure 4-1. Viewer Display after Loading the Sample Picture.edf File

4.1 Inspector Window

The Inspector Window consists of 2 tabs, the Data Tab and the Preferences Tab (see Figure 4-2).

4.1.1 Data Tab

The Data Tab consists of 3 panels (Figure 4-2, left Panel). The top panel provides a tree view of the viewing session. The first level of the tree view contains trial-grouping nodes ( ). EyeLink Data Viewer lists trials within a viewing session by either data file or by experimental conditions. Each trial-grouping node has a set of tree leaves representing the trials ( ) that are contained within that node.

The middle panel represents a list of components that are within the selected node of the analyses session tree. If a trial is selected in the viewing session tree, a list of visible events is displayed. If an Interest Area Set is selected, a list of interest areas that make up the set are selected.

The bottom panel is a table representing the properties of the selected tree node or selected list component. For example, if a fixation is selected, all properties of the fixation are listed in the properties table. Some properties, like color, are editable, by pressing on the property value with the mouse.

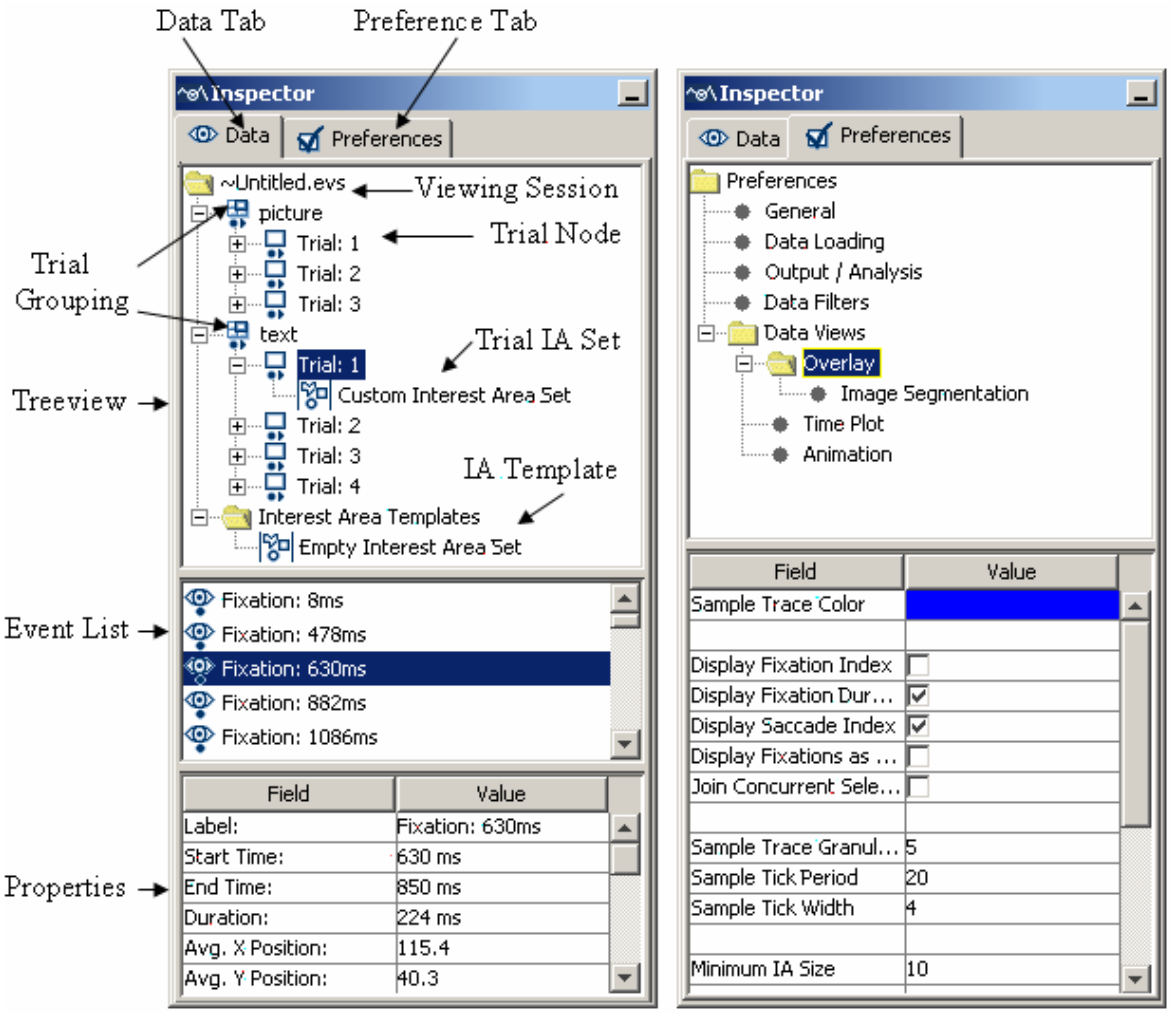


Figure 4-2. Components of the Inspector Window (Left: Data Tab; Right: Preference Tab)

4.1.1.1 Data Tree Hierarchy

When a data file is loaded, the tree view panel lists the possible analysis levels in a hierarchical order. The user can obtain information on the trial groups and individual trials. Within each trial, statistics on all events (fixations, saccades, blinks, button presses, and messages) and interest areas can also be retrieved.

4.1.1.2 Trial Grouping

By clicking on a trial-grouping node ( ), information on this trial group can be obtained in the bottom panel of the data inspector. Typically, this includes the label of group (values of the grouping variables), total number of trials, and configurable interest area information (see section 6.1.3 on how to perform trial grouping). By default, trials in a viewing session are grouped by the EyeLink data files loaded. The following table lists the group properties if trials are grouped by data file. Those fields that are editable in the viewer are marked with an asterisk.

Field	Contents
Label *	The label of the trial group
Number Trial	The total number of trials in the trial group
File	The file name of the recording (with the path information)
Eyelink Version	Tracker version of the EyeLink system
Sampling Rate	250 or 500 Hz
Eyes	Which eye produced the recording (the value could be Left, Right, or Binocular)
Mode	Pupil only mode, or pupil with corneal reflection
Pupil Data Type	Whether the pupil size is set by area or diameter
Gaze Data type	Raw (raw pupil-center position or pupil minus corneal if running in pupil-CR mode as measured by the image-processing system), Gaze (actual gaze position on the display screen, fully compensated for head position), or HREF (the tangent of the rotation angle of the eye relative to the head)
Display Width *, Display Height *	Screen resolution (width and height in pixels) of the recording displays. By default, this sets the trial view window resolution to the value specified by display Coordinates messages. If you want to change the screen resolution, make sure that you first close the Trial View Window first, change the Display Width and Display Height values, and then open another trial view window.

4.1.1.2.1 Deleting a group of trials

To remove a group of trials from the analysis, select the grouping node, click the right mouse button and click on the "delete" menu item. If trials contained within a grouping node are deleted from the data viewer session, they will be permanently removed from the tree view (the EDF file has to be reloaded before information on that file can be accessed again).

4.1.1.3 Trial Summary

By clicking on the trial node ( ) of the tree view, information on participants' performance in individual trials can be retrieved. Once a trial is selected for analysis, the middle panel of the Data Tab lists all of the visible events and messages in the trial and the bottom-panel provides a general summary of performance in that trial. The following table lists the trial-level analysis variables. Those fields that are editable in the viewer are marked with an asterisk.

Field	Contents
Label *	Label of the trial
Index	Trial sequence
Recording File	File name of the recording
Start Time	Timestamp when the trial recording started (in milliseconds since EyeLink tracker was activated)
End Time	Timestamp when the trial recording ended (in milliseconds since EyeLink tracker was activated)
Duration	Duration (in milliseconds) of the trial recording
Reaction Time	Configurable response time determined by the Reaction Time Definition associated with the trial. Use the value of Duration if RT is undefined.
RT Event Index	Index of event that triggered the end of the reaction time; -1 when NO_MATCH. The index is relative to a specific event type; for example an index of 5 for a Saccadic RT means the 5th saccade in the trial.
RT Event Type	The way in which the trial reaction time is ended, possible values are TIMEOUT, BUTTON, FIXATION, SACCADE, MESSAGE, or NO_MATCH
RT Definition Label	Label of the reaction time definition (see section 6.3.1 Managing Reaction Time Definitions). "." if undefined; "CUSTOM" if the RT definition is a custom one (see Section

	7.4 Reaction Time Definitions).
Average Fixation duration	Average duration (in milliseconds) of all fixations in the trial
Average Saccadic Amplitude	Average size (in degrees of visual angle) of the saccades in the trial
Report Hidden *	Whether or not to hide the trial from output reports.
Interest Area Set *	Setting of the interest areas ("Custom Interest Area Set" or "Empty Interest Area Set"). If interest areas have been defined, they can be removed by selecting "Empty Interest Area Set"
Number Samples	Total number of samples in the trial recording
Number Fixations	Total number of fixations in the trial recording
Number Saccades	Total number of saccades in the trial recording
Number Blinks	Total number of blinks in the trial recording
Number Button Presses	Total number of button presses in the trial recording
Number Messages	Total number of messages in the trial recording
X Resolution, Y Resolution	Angular resolution at current gaze position (in screen pixels per visual degree)

4.1.1.3.1 Hiding a Trial

To hide a trial from the output reports

1) Click the trial to hide in the top panel of the data tab.
2) In the bottom panel of the data tab (which contains properties for the trial), find the entry "Report Hidden" and change the current setting.

4.1.1.3.2 Deleting a Trial

To delete a trial from the Data Viewer, simply place the mouse over that trial node, click the right mouse button and select Delete. The trial is permanently removed from the data viewing session and all other trial indexes are updated accordingly.

4.1.1.4 Interest Area Templates

An interest area template is a .IAS file that contains a set of interest areas. If the same interest areas are used for several trials, instead of repeating the procedure of creating interest areas for each individual trial, an interest area template can be loaded to supply segmentation information for those trials efficiently. The property panel lists the following summary statistics for an interest area template. Those fields that are editable in the viewer are marked with an asterisk.

Field	Contents
Name *	Label of the custom interest area set
IA Count	Total number of interest areas defined in the trial
IsCustom	Whether the current set of interest areas is user-defined (true) or an interest area template (false)
Image Name Mapping	If the "Auto Select IAS for Trial" property in the "Output/Analysis" preference settings is true, the value in this field will be used to associate the IAS to trials automatically (see section 5.8.8 "Automatic Trial Image-Interest Area Set Association" for details).

4.1.1.5 Custom Interest Area Set/Empty Interest Area Set

For each trial, the tree view also shows whether or not a custom interest area set has been defined for the trial. If there is no interest area set, the node will be "Empty Interest Area Set". The property panel lists the same elements as the interest area templates, except that the IsCustom field is "true" for the custom interest area set.

4.1.2 Preferences Tab

The preferences tab (Figure 4-2, right panel) provides access to all the elements of the data viewer that can be configured by the user. These include everything from the default colors used for displaying events, to the elements of an EDF file to load. These elements are broken down into the following five categories: General Preferences, Data Loading Preferences, Output/Analysis Preferences, Data Filters Preferences, General Trial View Preferences, Spatial Overlay View Settings, Temporal Graph View Settings, and Animation Playback Settings.

4.2 Trial View Window

The Trial View window displays the data of a selected trial in a Spatial Overlay Mode, a Temporal Graph Mode, or an Animation Playback Mode. Selecting a trial in the Data Inspector tree view shows the trial's data in a Trial View Window. The user can have several Trial View Windows open at one time by right clicking on a trial in the Inspector window and selecting "New Window" in the popup menu.

4.2.1 Selecting Data Elements to Display

At anytime event visibility can be toggled on/off within the Trial View Window. For example the button in the Application Desktop toggles the visibility of Fixation Events.

	Toggle Fixation Event Visibility
	Toggle Saccade Event Visibility
	Toggle Blink Event Visibility
	Toggle Message Event Visibility
	Toggle Button Event Visibility
	Toggle Sample Visibility
	Toggle Interest Area Visibility

4.2.2 Cloning a Trial View

From the menu, choose:

Window → Clone Window.

This allows, for example, both the temporal graph and spatial overlay views to be shown at the same time on the desktop. You can tile the windows together. Note that event selection in one view will automatically cause the same events to be selected in the other view.

4.2.3 Tiling/Cascading Windows

To arrange all open trial view windows, from the menu, select:

Window → Tile

or

Window → Cascade

Figure 4-3 shows an example of tiling three open trial view (spatial overlay, temporal graph, and animation modes) windows.

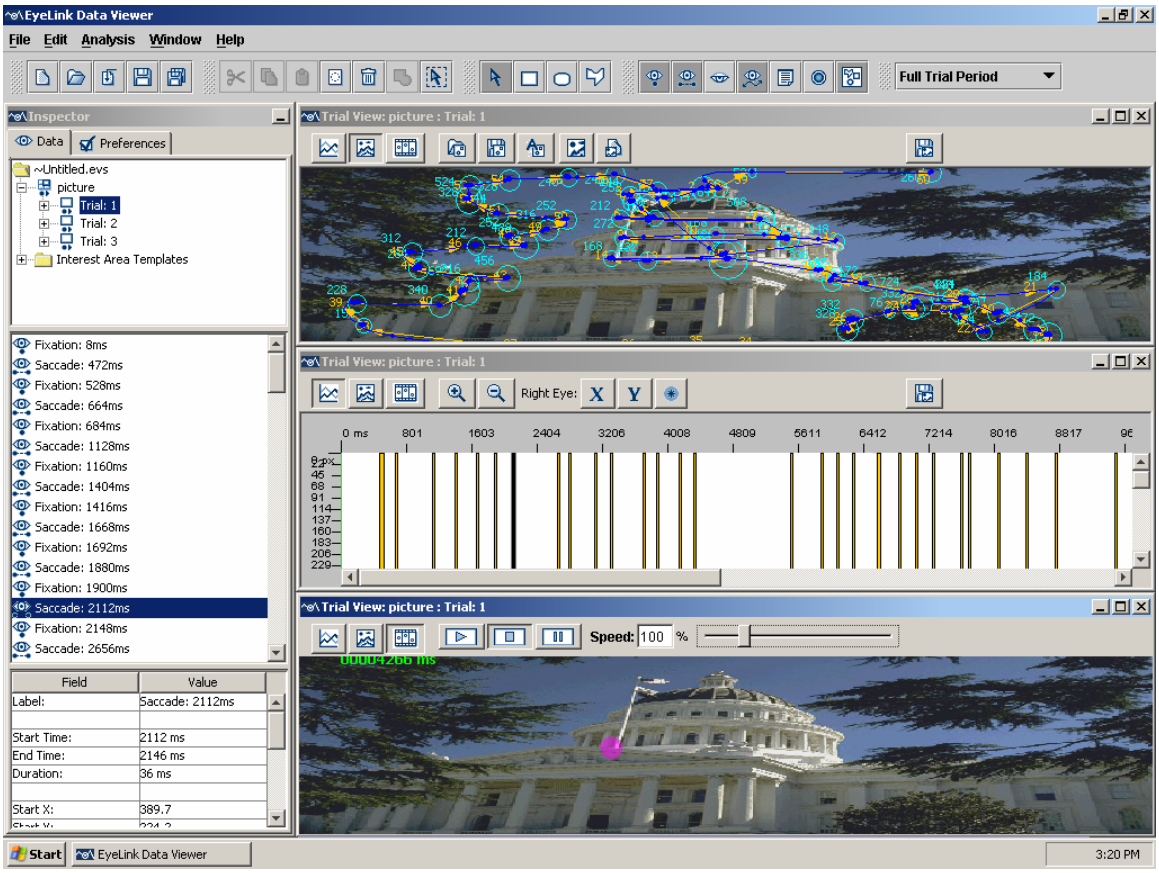


Figure 4-3. Tiling Trial View Windows.

4.3 Spatial Overlay Trial View

The Spatial Overlay view (see Figure 4-4) is selected by pressing the button in the Trial View window. This view lets you look at events and samples by placing them where they were detected in space. If the image that was presented during the trial is available, it can be placed in the overlay view.

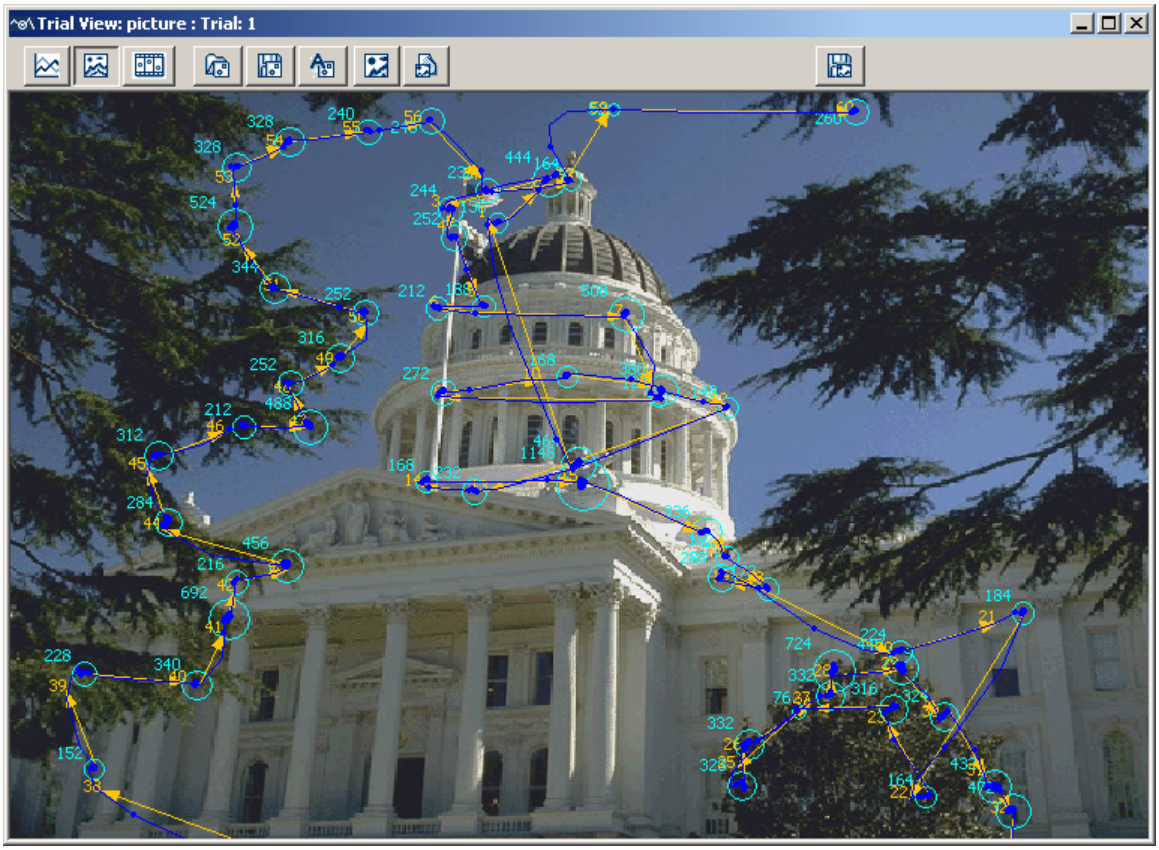


Figure 4-4. Sample Spatial Overlay Trial View

The following buttons are available from the spatial overlay mode:

	View Trial Data in 2D Temporal Graph Mode: Select the temporal graph mode.
	View Trial Play Back Animation: Select the playback animation mode.
	Import Area of Interest File: Loads an interest area set file and sets the interest areas for this trial. Any existing interest areas are deleted from the trial. After loading, the Interest Area Set for the trial is set to "Custom".
	Auto Segment Image to Interest Areas: Creates interest areas automatically for the trial bitmap.
	Save the Interest Area Set File: Saves the trials interest area set to a file.
	Display Image in Full. If enabled, overlay is not scaled to size of Trial Viewer Window and is instead set to actual size (One pixel of overlay corresponds to one pixel of trial display).
	Change the Overlay Image: Select the image to use as the background of the overlay. Any existing background graphics are deleted.
	Save Trial View as Image: Creates an image of the spatial overlay view

Changes from the previous versions: Note that when the background image for a trial is manually changed with the "Change the Overlay Image" button, please also check for the "Fit Overlay Image Change to Display" setting in the Data Views->Overlay preference. If that setting is true, the image is scaled to fit the display dimensions for the trial. If false, the image size is not altered and the image is centered on the trial overlay view.

4.4 Temporal Graph Trial View

The Temporal Graph View (see Figure 4-5) allows the user to view trial data as a trace plot, where the X axis represents time and the Y axis represents the X / Y gaze location, pupil size (dived by a factor of 10), acceleration, and velocity data. To view trial data in this mode, select the button in the top left corner of the Trial View Window.

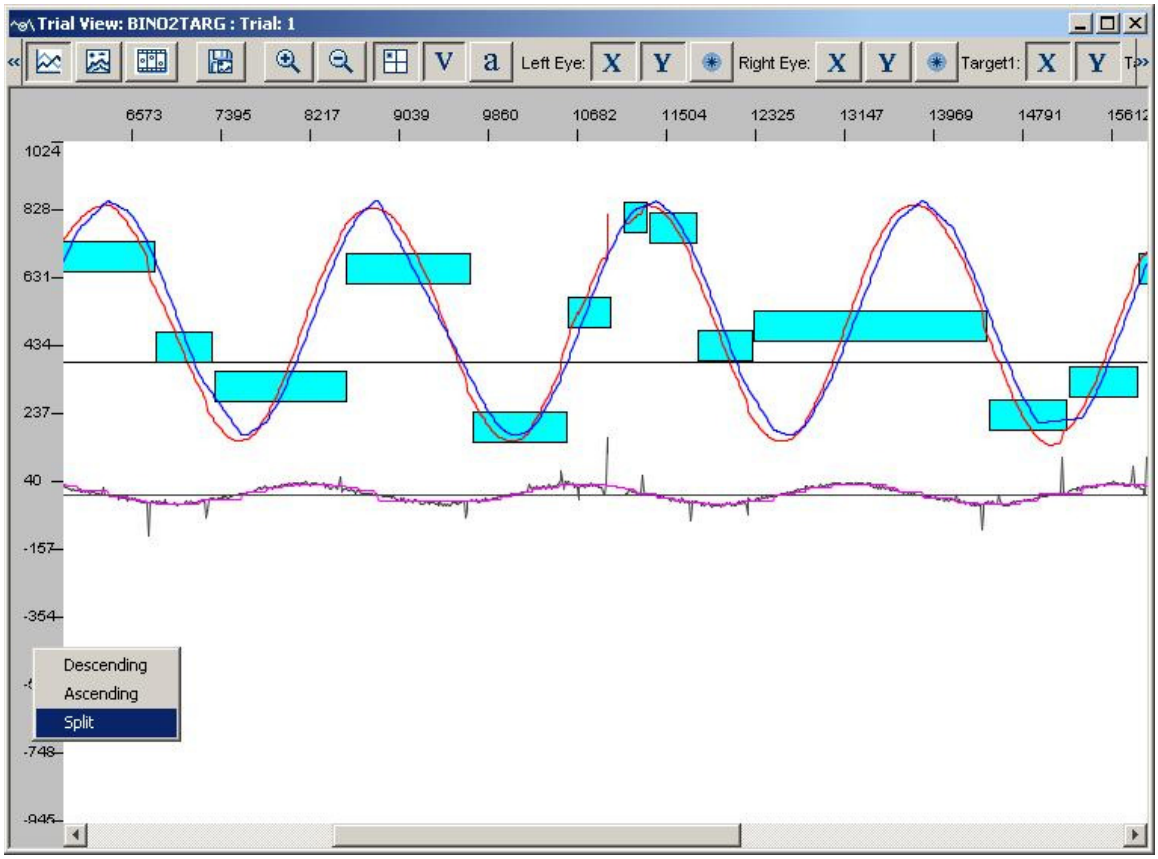


Figure 4-5. Sample Temporal Graph Trial View

4.4.1 Viewing Sample and Target Data

Time plot view will show trace plots only if the EDF file contains samples and if sample are activated for viewing (i.e., the "Toggle Eye Sample Visibility" button on the Data

Viewer tool bar is selected). The position, velocity, and acceleration sample traces can be selected for viewing from buttons within the Trial Viewer Window.

	View Trial Spatially with Image Overlay: Select the spatial overlay mode
	View Trial Play Back Animation: Select the playback animation mode
	Zoom In Graph View: Zoom in to view details of a selected portion of data
	Zoom Out Graph: Zoom out the graph by a scale of 2
	Position Trace: Show the gaze or target position.
	Acceleration Trace: Shows the gaze or target acceleration data
	Velocity Trace: Show the gaze or target velocity data
	X Sample Trace: Toggle X trace visibility
	Y Sample Trace: Toggle Y trace Visibility
	Pupil Sample Trace: Toggle Pupil Trace Visibility
	Save Trial View as Image: Creates an image of the temporal graph view

Changes from the previous versions: to show the eye or target traces in this version, the user needs to select the type of data (position, velocity, or acceleration) and data source (x, y, pupil of left eye and/or right eye, x, y of target1 and/or target2) to be shown. To show the position, velocity, and acceleration traces of target(s) in this view, messages on the current position of the target(s) must be recorded in the EDF file. These messages should contain a target position keyword ("!V TARGET_POS" by default and can be configured in the "target position string" of Data Loading preference settings), followed by parameters of the individual targets.

The scale in which the vertical data is displayed can be changed by clicking the right mouse button when the mouse cursor is placed on the Y-axis and choose one of the following options: ascending (large values on the Y-axis appear on the top of the screen), descending (large values on the Y-axis appear at the bottom of the screen), or split (0 appear in the middle of the screen, positive values on the top and negative values at the bottom).

The X, Y, and pupil traces can be highlighted. Press the 'x' key to highlight the X trace, press the 'y' key to highlight the Y trace, and press the 'p' key to highlight the Pupil trace. If pressing one of these keys does not highlight the intended sample traces, please make sure that the trial view window is currently in focus (double clicking anywhere the sample traces are plotted to set the keyboard focus to the trial view window).

Various aspects of the time plot view can be configured in the preference settings (Preferences -> Data Views -> Time Plot). For example, the user may change the colors of the sample traces, the scaling factor for plotting the acceleration, velocity, and pupil size data, total number of initially visible samples in the temporal graph view window, etc.

4.4.2 Zooming Operations

The temporal graph can be zoomed in and out. To zoom into an area of the temporal graph:

1) Hold the Shift key down or press the button.
2) Position the mouse on the temporal graph at the location of the upper left hand corner of the area you wish to zoom into.
3) Press the mouse button and drag the mouse to the lower right hand corner of the area you wish to zoom into.
4) Release the mouse button
5) Release the Shift key.

The graph will be magnified so that the area you selected fills the Trial View Window.

Tip: Holding the CTRL key while defining the zoom in region will change to time period to be magnified only; the spatial range displayed is not altered.

To zoom out the graph, press the button. The temporal graph will be zoomed out by a factor of 2.

4.5 Animation View

The Animation View (see Figure 4-6) is selected by pressing the button in the Trial View window. This view plays back the gaze position (superimposed on the background image that the participant was looking at while the data was being recorded), with a concurrent time code displaying the time from the start of trial recording.

Several controls are available for the animation view. The user can start, stop, or pause the playback by clicking the appropriate button. The speed of playback can also be adjusted (the user modifies the speed value and then press the "Enter" key to register the change). A trackbar control displays the progress of the playback and lets the user select a position to start playback.

	View Trial Spatially with Image Overlay: Select the spatial overlay mode
	View Trial Data in 2D Temporal Graph Mode: Select the temporal graph mode
	Playback Trial: Starts playing back the trial data
	Stop Trial Playback: Stops the playback and resets the time code and gaze cursors.
	Pause Trial Playback: Pauses the playback

	Forward Step: Each click on this button advances the playback by one video frame.
	Save Trial to Movie File: Save the playback of the trial into a movie file

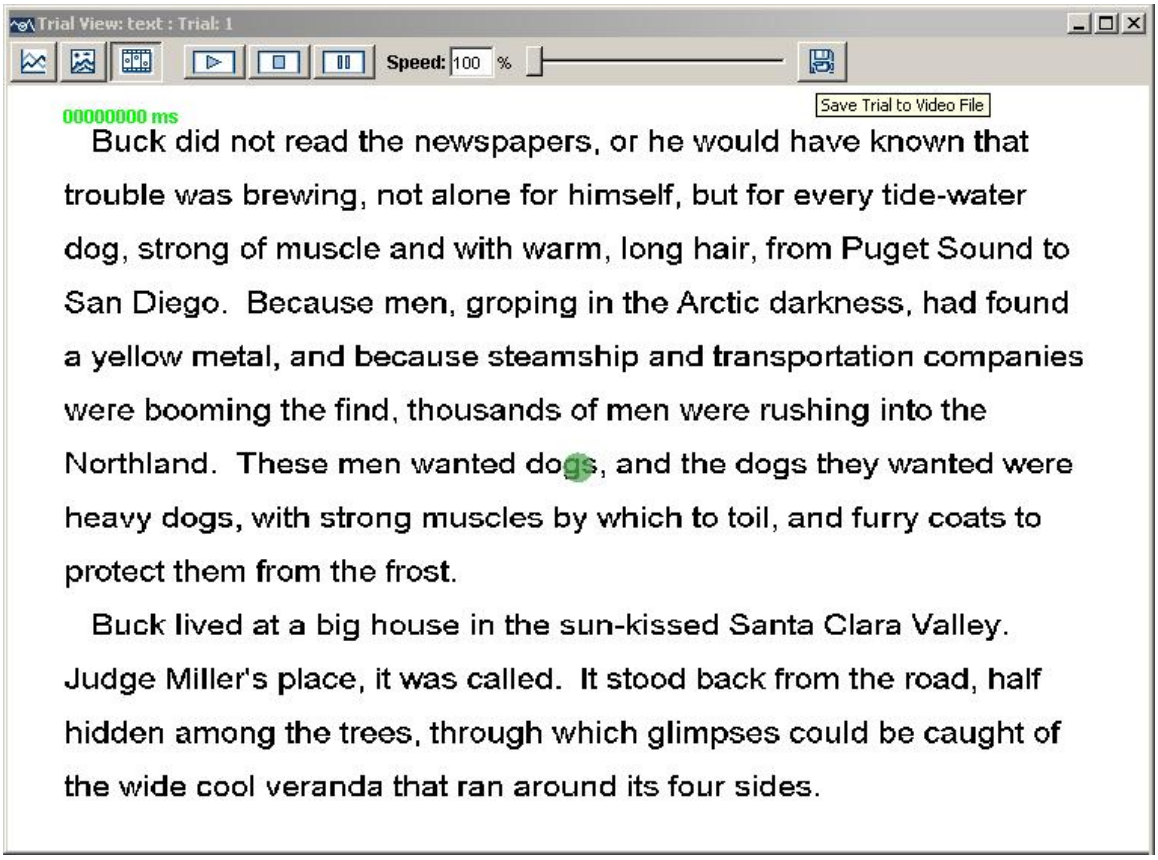

Trial View: text : Trial: 1
Speed: 100 %
Save Trial to Video File
00000000 ms
Buck did not read the newspapers, or he would have known that trouble was brewing, not alone for himself, but for every tide-water dog, strong of muscle and with warm, long hair, from Puget Sound to San Diego. Because men, groping in the Arctic darkness, had found a yellow metal, and because steamship and transportation companies were booming the find, thousands of men were rushing into the Northland. These men wanted dogs, and the dogs they wanted were heavy dogs, with strong muscles by which to toil, and furry coats to protect them from the frost.
Buck lived at a big house in the sun-kissed Santa Clara Valley. Judge Miller's place, it was called. It stood back from the road, half hidden among the trees, through which glimpses could be caught of the wide cool veranda that ran around its four sides.

Figure 4-6. Sample Playback Animation View.

To save the playback of trial data into a movie file, click on the "save To Movie" button ( ) on the trial view window toolbar. In the following "Movie Save Options" dialog box, enter the movie file name, file type (.AVI or .MOV), frame rate, and compression method. Click "Start" to begin moving saving. Depending on the size of recording file, this may take a long time to finish. At any point, user can press "ESC" key to stop the saving process.

Playing back video clips in the animation view is also supported if the EDF file is created from an SR Research Experiment Builder recording. The video clip must be encoded in XVID format and a computer with P4 CPU is required for playback in Data Viewer.

5 Working with Events, Samples, and Interest Areas

In addition to providing a file-based and a trial-based summary of performance, the EyeLink Data Viewer allows a detailed examination of event data such as fixations, saccades, blinks, buttons, messages, as well as raw sample data.

5.1 Common Operations

The EyeLink Data Viewer allows the user to carry out various manipulations over the events, such as selecting a portion of data for further scrutiny, excluding or deleting a subset of events from analysis, performing drift correction on fixations, merging neighboring fixations and saccades, etc. Selecting, hiding, and deleting operations are common to all event types (fixations, saccades, buttons, blink events, and messages) whereas merging and drift correction is available to fixation and saccade events only. The common operations are discussed in this section whereas the unique operations pertaining to certain types of events are documented in the relevant event section.

5.1.1 Selecting Events

To select an event (fixation, saccade, blink, button, or message), place the mouse cursor over the event either in the spatial overlay/temporal graph view or in the event list of the inspector window and click the left mouse button.

To select more than one event, hold the CTRL key down and select the target event, until all desired events are selected. If all events in a trial are to be selected, simply click the Select All Visible Item button on the toolbar (or click the right mouse button and select "Select All").

To select a group of events within a square region, place the mouse cursor at the top-left corner of the region. Click and hold down the left mouse button, drag the mouse cursor to the bottom-right corner of the square region, and then release the left mouse button.

Tip: Holding the CTRL key while selecting an event leaves previously selected events selected. If the CTRL key is not pressed, previously selected events are unselected.

5.1.2 Deleting Events

Select the events and click the Delete Selected Items button on the toolbar (or click the right mouse button and select "delete"). If an event is deleted, it will be permanently removed from the temporal graph view, spatial overlay view, as well as the output reports, and cannot be "undeleted". In addition, deleting a fixation or saccade event will

have an impact on other temporally contiguous events. For example, deleting a fixation will merge the saccades on either side of the fixation into one saccade. Similarly, deleting one saccade will merge the fixations on either side of the saccade into one big fixation.

5.2 Fixations

To examine the fixation information in the data file, first make sure that the fixation events are visible. This is done by ensuring that the Toggle Fixation Event Visibility button in the application desktop toolbar is selected.

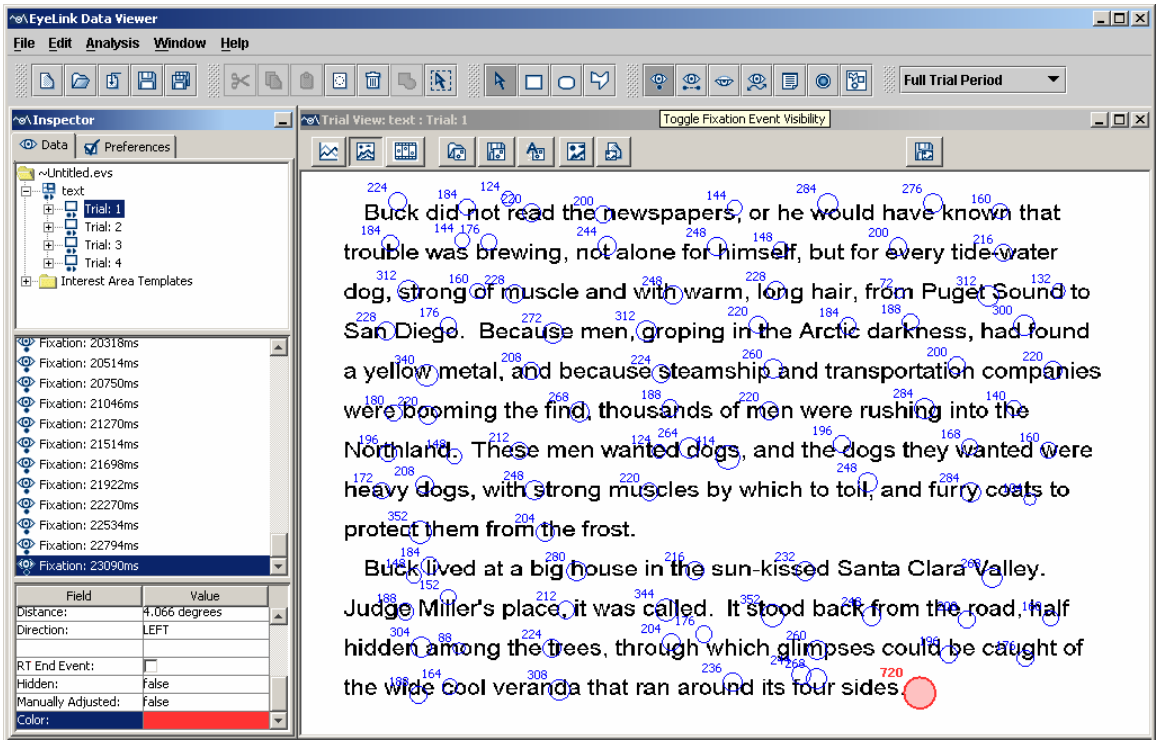

EyeLink Data Viewer
File Edit Analysis Window Help
Full Trial Period
Inspector
Data Preferences
~Untitled.evs
text
Trial: 1
Trial: 2
Trial: 3
Trial: 4
Interest Area Templates
Fixation: 20318ms
Fixation: 20514ms
Fixation: 20750ms
Fixation: 21046ms
Fixation: 21270ms
Fixation: 21514ms
Fixation: 21698ms
Fixation: 21922ms
Fixation: 22270ms
Fixation: 22534ms
Fixation: 22794ms
Fixation: 23090ms
Field
Value
Distance:
4.066 degrees
Direction:
LEFT
RT End Event:
Hidden:
false
Manually Adjusted:
false
Color:
Trial View: text : Trial: 1
Toggle Fixation Event Visibility
Buck did not read the newspapers, or he would have known that trouble was brewing, not alone for himself, but for every tide-water dog, strong of muscle and with warm, long hair, from Puget Sound to San Diego. Because men, groping in the Arctic darkness, had found a yellow metal, and because steamship and transportation companies were booming the find, thousands of men were rushing into the Northland. These men wanted dogs, and the dogs they wanted were heavy dogs, with strong muscles by which to toil, and furry coats to protect them from the frost.
Buck lived at a big house in the sun-kissed Santa Clara Valley. Judge Miller's place, it was called. It stood back from the road, half hidden among the trees, through which glimpses could be caught of the wide cool veranda that ran around its four sides.

Figure 5-1.Sample Spatial Overlay View of Fixation Events

The trial-view window (Figure 5-1, right panel) shows either a spatial overlay view or a temporal graph view of the fixation events. In the former view, fixations are represented as a hollow circle in the corresponding x, y coordinates on the trial bitmap, with fixation duration displayed near the top-left corner of the circle. In the temporal graph view, fixations are represented as a filled block. All fixation events in a selected trial are listed sequentially in the middle panel of the inspector window. Properties of a selected fixation are shown in the bottom panel of the inspector window. Each field of the fixation event property is described in the following table. Those fields that are editable in the viewer are marked with an asterisk.

Field	Contents
Label *	Label of the fixation
Eye	The eye to which the current fixation event is associated.
Start Time	Trial time [1] when the fixation starts. Please note that if an interest period filter is applied, the duration, start time, and end time of the fixations that overlap with the start or end of the interest period will be adjusted accordingly.
End Time	Trial time [1] when the fixation ends.
Duration	Duration (in milliseconds) of the fixation
Avg. X Position *, Avg. Y Position *	Average camera X, Y of pupil center
Angle	Angle between the horizontal plane and the line connecting the current fixation and the previous/next fixation
Distance	Distance (in degrees of visual angle) between the current fixation and the previous/next fixation
Direction	Direction ("LEFT", "RIGHT", "UP", or "DOWN") [3] relative to the current fixation in which the previous/next fixation is located
RT End Event *	Whether the current fixation is the reaction time end event (see section 6.3.1 for reaction time definition)
Hidden	Whether the current fixation is hidden from viewing and output analysis
Manually Adjusted	Whether the fixation has been shifted manually
Color *	To achieve better visibility, the color of the currently selected fixation can be changed by clicking on the color toolbox

Note [1] : System time refers to the timestamp (in milliseconds) since the EyeLink tracker was activated whereas the trial time refers to the time since the trial started. The default trial start time is the start of the trial recording (i.e., "START" message). If reaction-time definitions are applied, the trial-start time is reset at the start event of the RT definition (e.g., "SYNCTIME" message). A negative trial time means that the event or message occurred before the trial start time.

Note [2] : The calculation of the angle between the previous/next fixation and the current fixation is directional, with the arrow pointing towards the previous/next fixation (see Figure 5-2 for an illustration of angle calculation).

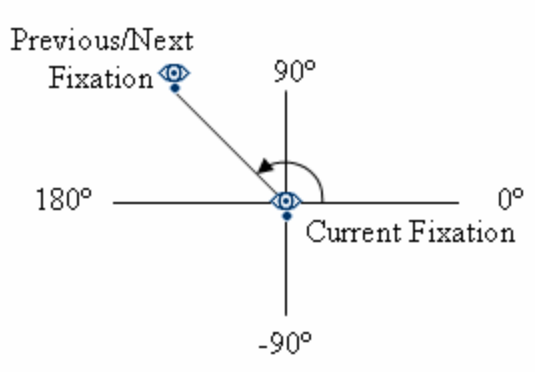


Figure 5-2. Diagram for Angle Calculation

Note [3]: The direction of the previous/next fixation relative to the current fixation is determined as "LEFT" if the angle is greater than 135º or less than -135º, "UP" if the angle is between 45º and 135º, "RIGHT" if the angle is between -45º and 45º, and "DOWN" if the angle is between -135º and -45º.

5.2.1 Selecting Fixations

In addition to the common method of event selection by mouse, fixations may also be selected by using the cursor keys (up, down, left, and right cursor keys). To select a group of temporally contiguous fixations, select the first fixation by mouse and press the up cursor key to select the next fixation, until all target fixations are selected. Use the down cursor key to unselect the recently selected fixations. The left or right cursor key can be used to choose a group of fixations earlier or later in the temporal sequence.

5.2.2 Merging Fixations

In some cases, two or more temporally contiguous fixations can be merged and represented as a "larger" fixation. To merge fixations, select the fixations and click the Merge Selected Items button on the toolbar (or click the right mouse button and select "merge").

Note: Only two or more temporally contiguous fixations can be merged. If fixations are selected that are not temporally contiguous, only the neighboring fixations will be merged.

5.2.3 Drift Correcting Fixations

Sometimes, a drift in the gaze position may occur due to poor system setup, headband slippage, or excessive head/body movement. Normally, the eye tracker operator would notice this problem and perform a recalibration or drift correction. If however, the issue was not addressed during recording, it may be possible to manually adjust the fixation events so that some degree of data analysis can still be performed.

5.2.3.1 Drift-correcting a Group of Selected Fixations

To perform drift correction:

1) Select the fixations to be drift corrected
2) Hold the ALT key down
3) Move the selected fixations with the cursor keys to the desired locations

Tip: In case several fixations on one single line (such as in reading research) are to be drift-corrected, another method is to select all of the desired fixations and press CTRL+D to align them to the same Y position (see Figure 5-3). This operation will fail if one or more fixations deviate more than 30 pixels in the Y dimension from the mean of the group of fixations to be drift-corrected in a batch (for example when fixations from different lines are selected). The tolerable deviation threshold and the X/Y dimension of alignment is set to 30 as a default and can be modified in the general trial view preference settings.

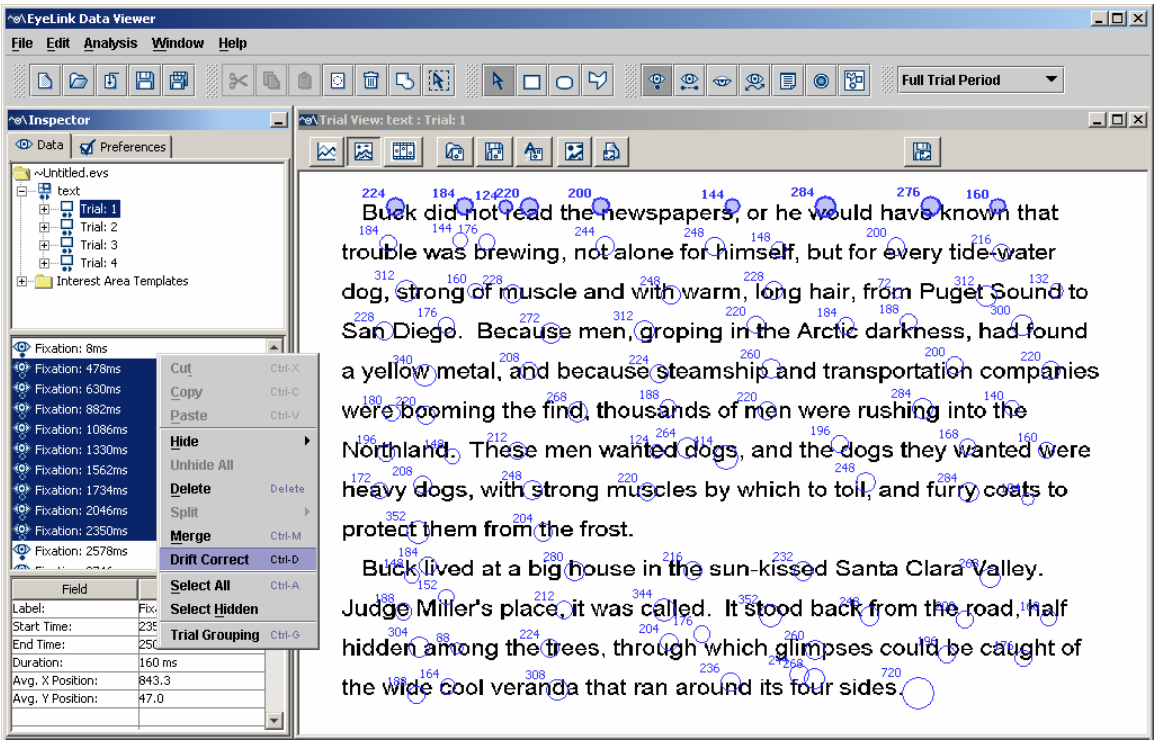

EyeLink Data Viewer
File Edit Analysis Window Help
Full Trial Period
Inspector
Data Preferences
~Untitled.evs
text
Trial: 1
Trial: 2
Trial: 3
Trial: 4
Interest Area Templates
Fixation: 8ms
Fixation: 478ms
Fixation: 630ms
Fixation: 882ms
Fixation: 1086ms
Fixation: 1330ms
Fixation: 1562ms
Fixation: 1734ms
Fixation: 2046ms
Fixation: 2350ms
Fixation: 2578ms
Cut Ctrl-X
Copy Ctrl-C
Paste Ctrl-V
Hide
Unhide All
Delete Delete
Split
Merge Ctrl-M
Drift Correct Ctrl-D
Select All Ctrl-A
Select Hidden
Trial Grouping Ctrl-G
Field
Label:
Start Time:
End Time:
Duration: 160 ms
Avg. X Position: 843.3
Avg. Y Position: 47.0
Trial View: text : Trial: 1
Buck did not read the newspapers, or he would have known that trouble was brewing, not alone for himself, but for every tide-water dog, strong of muscle and with warm, long hair, from Puget Sound to San Diego. Because men, groping in the Arctic darkness, had found a yellow metal, and because steamship and transportation companies were booming the find, thousands of men were rushing into the Northland. These men wanted dogs, and the dogs they wanted were heavy dogs, with strong muscles by which to toil, and furry coats to protect them from the frost.
Buck lived at a big house in the sun-kissed Santa Clara Valley. Judge Miller's place, it was called. It stood back from the road, half hidden among the trees, through which glimpses could be caught of the wide cool veranda that ran around its four sides.

Figure 5-3. Drift Correcting Fixations on One Line of Text.

5.2.3.2 Precise Drift Correction of a Single Fixation

To carry out more precise drift correction of one fixation,

1) Select the fixation to be drift corrected
2) In the property panel of the Inspector window, select the entry for “Avg. X Position” and type in the desired X position
3) Select the entry for “Avg. Y Position” and enter the desired Y position

Note: Drift correcting one fixation or a group of fixations changes the properties of some relevant events, such as the start/end point of a preceding or following saccade and its amplitude.

Tip: Before moving the fixations, it is desirable to turn off the interest area set by pressing Toggle Interest Area Visibility button in the application desktop toolbar. Otherwise, the interest area(s) within which the fixations appear will also be moved along.

5.2.3.3 Cleaning Fixations

For some studies, researcher may want to clean up fixations based on certain rules. Data Viewer provides two options for fixation cleaning.

1) Fixation Filter preferences

The user can filter out small fixations with "Merge Nearby Fixations", "Fixation Merging Amplitude Threshold", and "Fixation Duration Threshold" settings from the Data Filter preference. If the "Merge Nearby Fixations" option is checked, a fixation with a duration shorter than the value set in the "Fixation Duration Threshold" will be merged with a neighboring fixation, if the latter is within the distance set by the "Fixation Merging Amplitude Threshold".

2) Four-stage Fixation Cleaning (Important: This option was not intended for all users!)

For some reading studies, the users may want to apply a more refined fixation cleaning algorithm. This can be done by select the intended Trial node or Recording session node, click on the right mouse button, and select the "Clean" option.

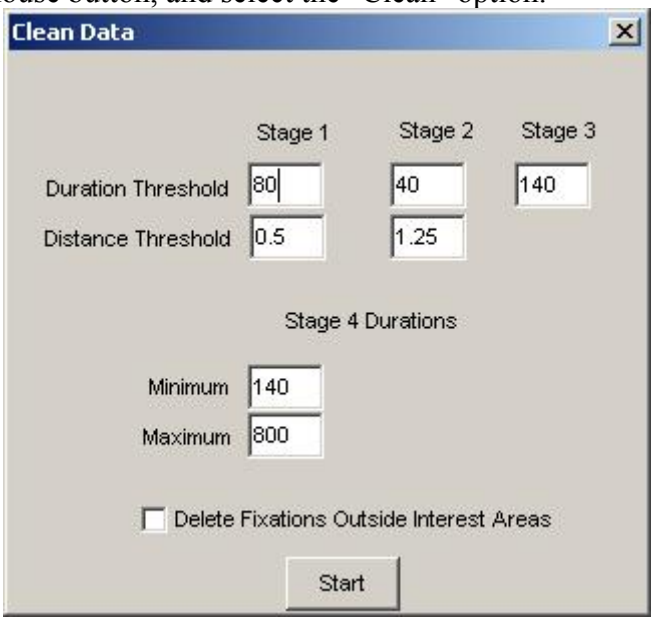


Figure 5-4. Options for Fixation Cleaning.

i) STAGE 1 For each interest area, Data Viewer checks for each fixation whether its time duration is shorter or equal to the duration threshold. If not, the current fixation will not be cleaned; otherwise, Data Viewer further checks the duration and distance of the fixation immediately before and after the current fixation. The fixation will be merged to the neighboring fixation if its duration is longer than the threshold value and its distance along the x-axis (in degrees) from the current fixation is shorter or equal to the distance threshold. If both the previous and next fixations meet the above criterion, the current fixation will be merged to the longer one of the two.

ii) STAGE 2 This stage is similar to STAGE 1 except for a different fixation duration and a distance value. For this stage to be effective, a shorter duration and a longer distance threshold should be used compared to Stage 1.

iii) STAGE 3. Data Viewer goes over the entire data and checks for interest areas which include at least three fixations smaller than the threshold duration and no fixations larger than the threshold duration. In such cases the shorter fixations are merged into the larger ones.

iv) STAGE 4 Data Viewer goes over the entire data and deletes every fixation which is shorter than Minimum duration or larger than the maximum duration threshold.

v) If "Delete Fixations Outside Interest Area" box is checked, this will remove those fixations falling out side of any interest area. Important: If no interest area is defined, all fixations will be removed!

5.3 Saccades

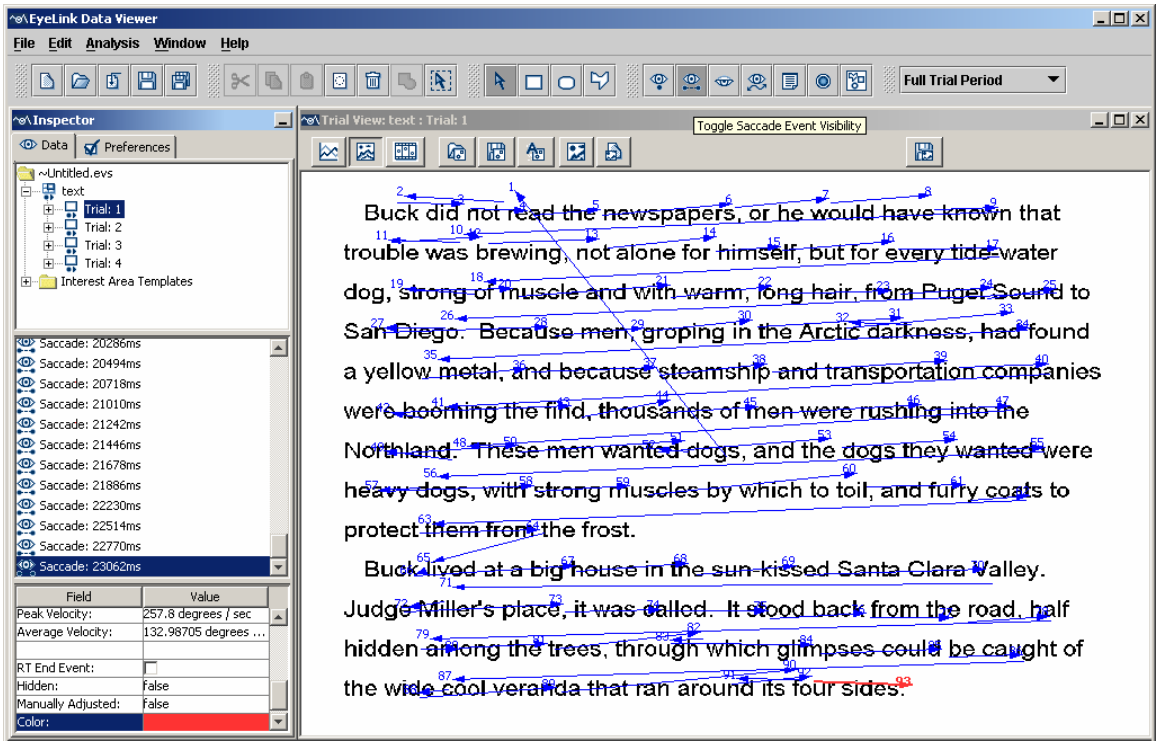

EyeLink Data Viewer
File Edit Analysis Window Help
Full Trial Period
Inspector
Data Preferences
~Untitled.evs
text
Trial: 1
Trial: 2
Trial: 3
Trial: 4
Interest Area Templates
Saccade: 20286ms
Saccade: 20494ms
Saccade: 20718ms
Saccade: 21010ms
Saccade: 21242ms
Saccade: 21446ms
Saccade: 21678ms
Saccade: 21886ms
Saccade: 22230ms
Saccade: 22514ms
Saccade: 22770ms
Saccade: 23062ms
Field
Value
Peak Velocity:
257.8 degrees / sec
Average Velocity:
132.98705 degrees ...
RT End Event:
Hidden:
false
Manually Adjusted:
false
Color:
Trial View: text : Trial: 1
Toggle Saccade Event Visibility
Buck did not read the newspapers, or he would have known that trouble was brewing, not alone for himself, but for every tide-water dog, strong of muscle and with warm, long hair, from Puget Sound to San Diego. Because men, groping in the Arctic darkness, had found a yellow metal, and because steamship and transportation companies were booming the find, thousands of men were rushing into the Northland. These men wanted dogs, and the dogs they wanted were heavy dogs, with strong muscles by which to toil, and furry coats to protect them from the frost.
Buck lived at a big house in the sun-kissed Santa Clara Valley. Judge Miller's place, it was called. It stood back from the road, half hidden among the trees, through which glimpses could be caught of the wide cool veranda that ran around its four sides.

Figure 5-5. Sample Spatial Overlay View of Saccade Events

Saccade events (see Figure 5-4) can be toggled on/off in both the spatial overlay and temporal graph views by clicking the Toggle Saccade Event Visibility button . A saccade is represented as an arrow in the spatial overlay view (pointing towards the endpoint) and as a colored solid line in the temporal graph view. The following table lists the properties of a saccade event. Those fields that are editable in the viewer are marked with an asterisk.

Field	Contents
Label *	Label of the saccade
Eye	The eye to which the current saccade event is associated.
Start Time	Trial time when the saccade starts
End Time	Trial time when the saccade ends
Duration	Duration (in milliseconds) of the saccade
Start X *, Start Y *	X, Y coordinates of the start position
End X *, End Y *	X, Y coordinates of the end position
Amplitude	Size (in degrees of visual angle) of the saccade
Peak Velocity, Average Velocity	The average and peak values of gaze velocity in visual degrees per second
RT End Event *	Whether the current saccade is the reaction time end event (see section 6.3.1 for reaction time definition)
Hidden	Whether the current saccade is hidden from viewing and

	output analysis.
Manually Adjusted	Whether the saccade has been adjusted manually
Color*	To achieve better visibility, the color of the currently selected saccade can be changed by clicking on the color toolbox.

5.3.1 Merging Saccades

Sometimes, a large saccade is followed by a small corrective saccade or vice versa. Thus, two or more temporally contiguous saccades could be merged. This can be done by selecting the saccades and clicking the Merge Selected Items button on the toolbar (or clicking the right mouse button and selecting "merge"). Once the saccades are merged, information on the ordinal sequence for the current and subsequent saccades is updated and the fixation between the two merged saccades is deleted.

Note: Only two or more temporally contiguous saccades can be merged. If saccades are selected that are not temporally contiguous, only the neighboring saccades will be merged.

5.4 Blink Events

Blink events (see Figure 5-5) can be toggled on/off by clicking the Toggle Blink Event Visibility button . Blink is represented as a colored solid line in both the spatial overlay view and the temporal graph view. Each field of the blink event properties is listed in the following table. Those fields that are editable in the viewer are marked with an asterisk.

Field	Contents
Label *	Label of the blink
Eye	The eye to which the current blink event is associated.
Start Time	Trial time when the blink starts
End Time	Trial time when the blink ends
Duration	Duration of the blink
Hidden	Whether the current blink is hidden from viewing
Color *	To achieve better visibility, the color of the currently selected blink can be changed by clicking on the color toolbox.

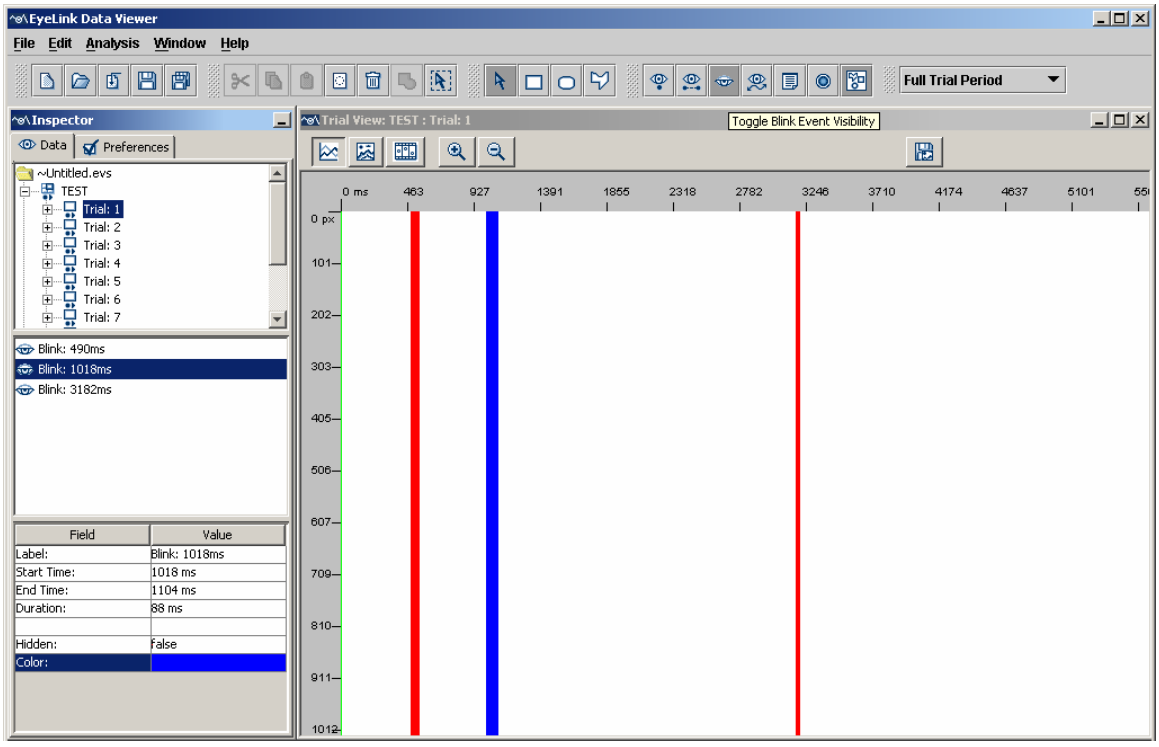


Figure 5-6. Sample Temporal Graph View of Blink Events

5.5 Messages

Messages, including message for built in EyeLink commands, can be placed in the EDF file to mark the start and end of a trial or important events such as display changes. Message events (see Figure 5-6) can be toggled on/off by clicking the Toggle Message Event Visibility button in the application desktop toolbar. A message is represented as a colored triangle in the temporal graph view and a colored square in the spatial overlay view, centering on the current gaze position. Each field of the message event property is listed in the following table. Those fields that are editable in the viewer are marked with an asterisk.

Field	Contents
Label *	Label of the message
Time	Trial time when the message was presented. Note that if the message is presented before the trial starts, a negative time value will be displayed.
Command	If the message is a command message, this lists the actual command used. The commands include simple drawing, built in audio messages, interest area commands, etc.
Text	Message text
X, Y	Concurrent gaze coordinates when the message is recorded (-

	100 if no gaze information was available for the time of the message event).
RT End Event *	Whether the current message is the reaction time end event (see reaction time definitions)
Hidden	Whether the current message is hidden from viewing.
Color *	To achieve better visibility, the color of the currently selected message can be changed by clicking on the color toolbox.

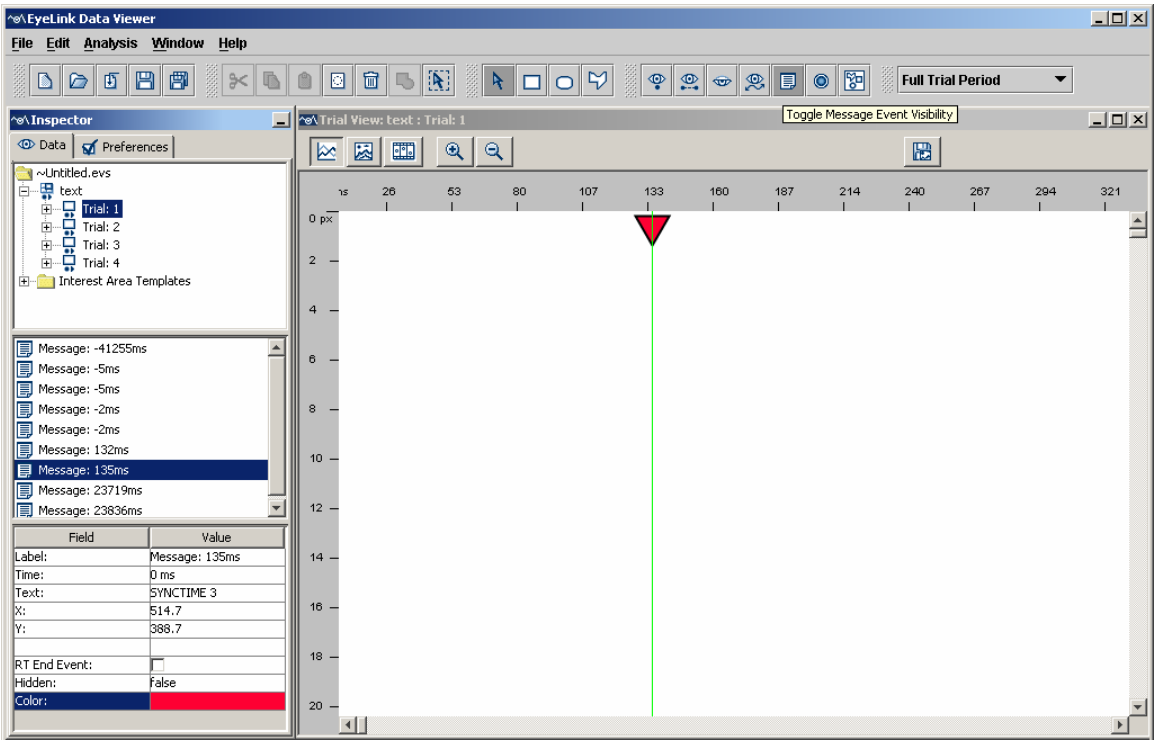


Figure 5-7. Sample Temporal Graph View of Message Events (Note that the default size of the message symbol in the temporal-graph preference settings has been changed).

5.5.1 Import Message List

Experiments should place certain messages into the EDF file to enable Data Viewer to process the files more efficiently. Examples of these commands include defining the image to overlay, specifying trial variables, defining a start time of RT definition, etc. These messages will be timestamped with an accuracy of 1 millisecond from the time sent, and can be used to mark important events such as display changes. If the user forgot to write these messages when the experiment was created, these messages can still be imported from a text file.

The loaded message list file must be an ASCII file and each line must be a valid EyeLink MSG line in the format of:
MSG EDF_time [Offset] Message_text

where:

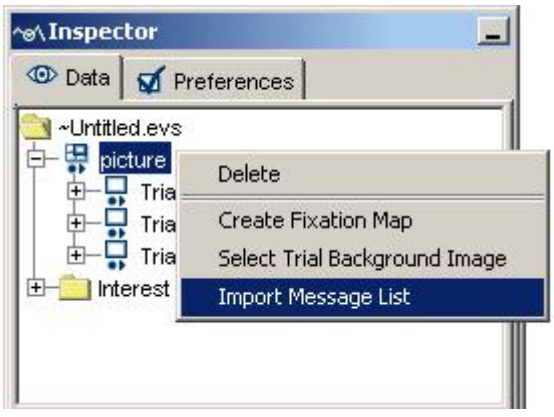
- EDF_time must be an integer. If this field is positive, it is assumed to be the absolute EDF timestamp to be used for the message (e.g., a value of 62798072 for EDF_time field will place the message in a trial which started after 62798072 and ended before 62798072). If EDF_time is negative, the -EDF_time = trial index of the message in the EDF file. A value of -1 would mean the first trial in the file and -4 would mean the 4th trial in the file. In this case, the message EDF time is set to the start of the trial time in this case.
- Offset is optional, and must be an integer if specified. Offset is subtracted from EDF_time to generate the real message time. For example, a message line of "MSG 2435806 -14 !V APLAYSTART 0 1 waves/1.wav" suggests that the event the message was referring to (APLAYSTART) actual happened at time 2435820.
- Message_text can be any string up to 100 characters in size that starts with a non-numeric character.
- Lines that do not follow these rules are ignored.

e.g.,

```
MSG 2435806 -14 !V APLAYSTART 0 1 waves/1.wav
MSG 2436376 -14 !V APLAYSTOP 12578 1 waves/1.wav
MSG  62798072 0 POSN 174 384
MSG  62798072 0 POSN 185 384
```

To load the message list file:

1) Select the EDF file label in the treeview panel of the Inspector Window.
2) Click on the right mouse button and select "Import Message List".
3) In the following "Open" dialog box, go to the directory where the message list file is stored and choose the file.



After the message list file is imported into the session, a dialog box will be presented to show the number of valid messages imported.

5.6 Button Events

Button events (see Figure 5-7) can be toggled on/off by clicking the Toggle Button Event Visibility button . A button event is represented as a colored triangle in the

temporal graph view and a colored square in the spatial overlay view, centering on the current gaze position. The following table lists the properties of a button event. Those fields that are editable in the viewer are marked with an asterisk.

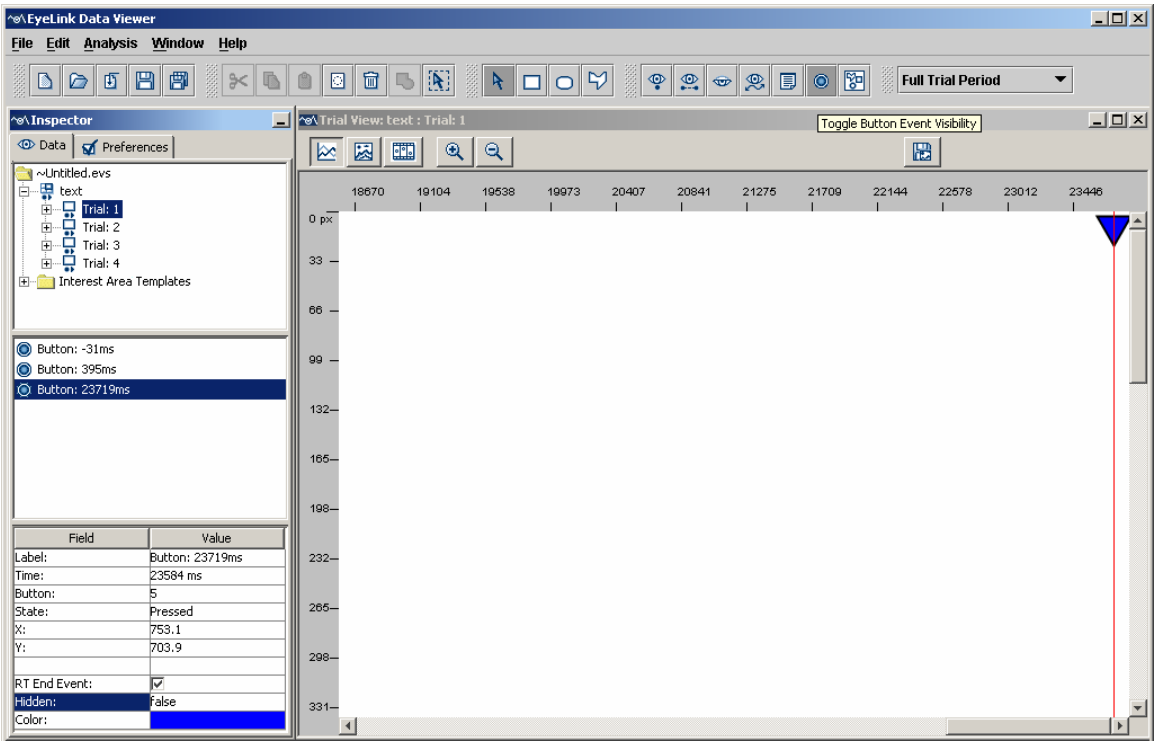


Figure 5-8. Sample Temporal Graph View Showing the Button Events (Note that the default size of the button symbol in the temporal-graph preference settings has been changed).

Field	Contents
Label *	Label of the button event
Time	Trial time when the button was pressed/released. Note that if the button event occurs before the trial starts, a negative time value will be displayed
Button	Button ID
State	Button pressed or released
X, Y	Concurrent gaze coordinates when the button is pressed/released (-100 if no gaze information was available for the time of the button event).
RT End Event *	Whether the current button event is the reaction time end event (see reaction time definitions).
Hidden	Whether the current button event is hidden from viewing and output report.

Color *	To achieve better visibility, the color of the currently selected button event can be changed by clicking on the color toolbox.

5.7 Samples

Samples can be toggled on/off by clicking the Toggle Eye Sample Visibility button in the desktop toolbar. In the spatial overlay view (Figure 5-8, left panel), the samples are overlaid on the trial bitmap, forming the sample path of the viewing process. In the temporal graph view (Figure 5-8, right panel), the *xy* coordinates of the samples as well as the concurrent pupil size are plotted as a function of trial time.

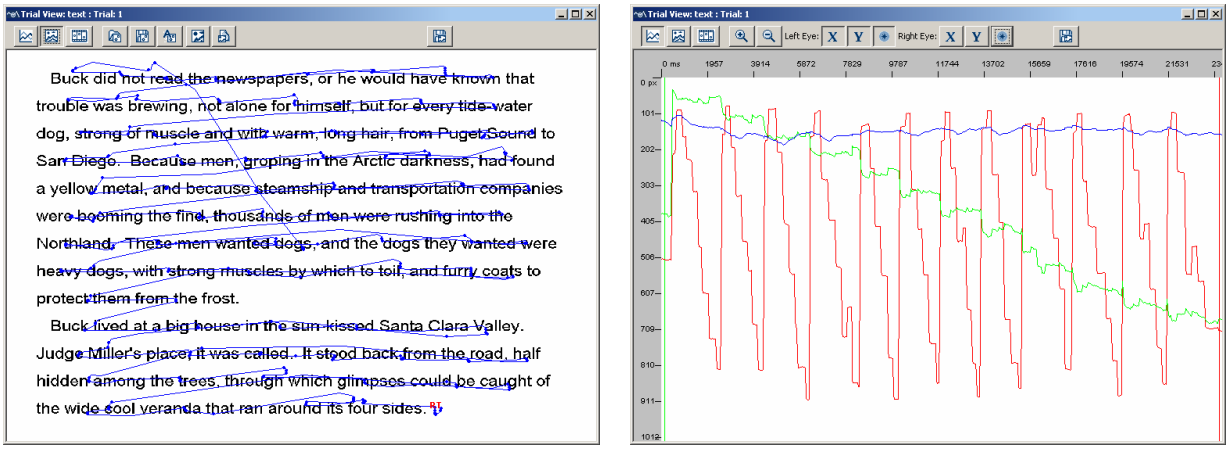

Trial View: text : Trial: 1
Buck did not read the newspapers, or he would have known that trouble was brewing, not alone for himself, but for every tide-water dog, strong of muscle and with warm, long hair, from Puget Sound to San Diego. Because men, groping in the Arctic darkness, had found a yellow metal, and because steamship and transportation companies were booming the find, thousands of men were rushing into the Northland. These men wanted dogs, and the dogs they wanted were heavy dogs, with strong muscles by which to toil, and furry coats to protect them from the frost.
Buck lived at a big house in the sun-kissed Santa Clara Valley. Judge Miller's place, it was called. It stood back from the road, half hidden among the trees, through which glimpses could be caught of the wide cool veranda that ran around its four sides.
Trial View: text : Trial: 1
Left Eye: X Y Right Eye: X Y

Figure 5-9. Sample Spatial Overlay View (left) and Temporal Graph View (right) of Raw Sample Data

Note: By default, samples are not loaded into the viewer when a data file is imported. To load samples into the data viewer, change the Load Samples property in the Preferences → Data Loading tab.

Tip: In the Spatial Overlay trial view, if samples are visible at the same time as events, when an event is selected, all samples used to generate that event are also selected.

5.8 Interest Areas

To access information on interest areas in a trial, first click on the interest area button ( ) of that trial in the tree view panel of the inspector window (see Figure 5-9). The node will read as "Custom Interest Area Set" if custom interest areas are loaded or created but as "Empty Interest Area Set" if no interest areas are defined. The middle panel of the inspector window lists all available interest areas in that trial. The following

table lists the properties of an interest area. Those fields that are editable in the viewer are marked with an asterisk.

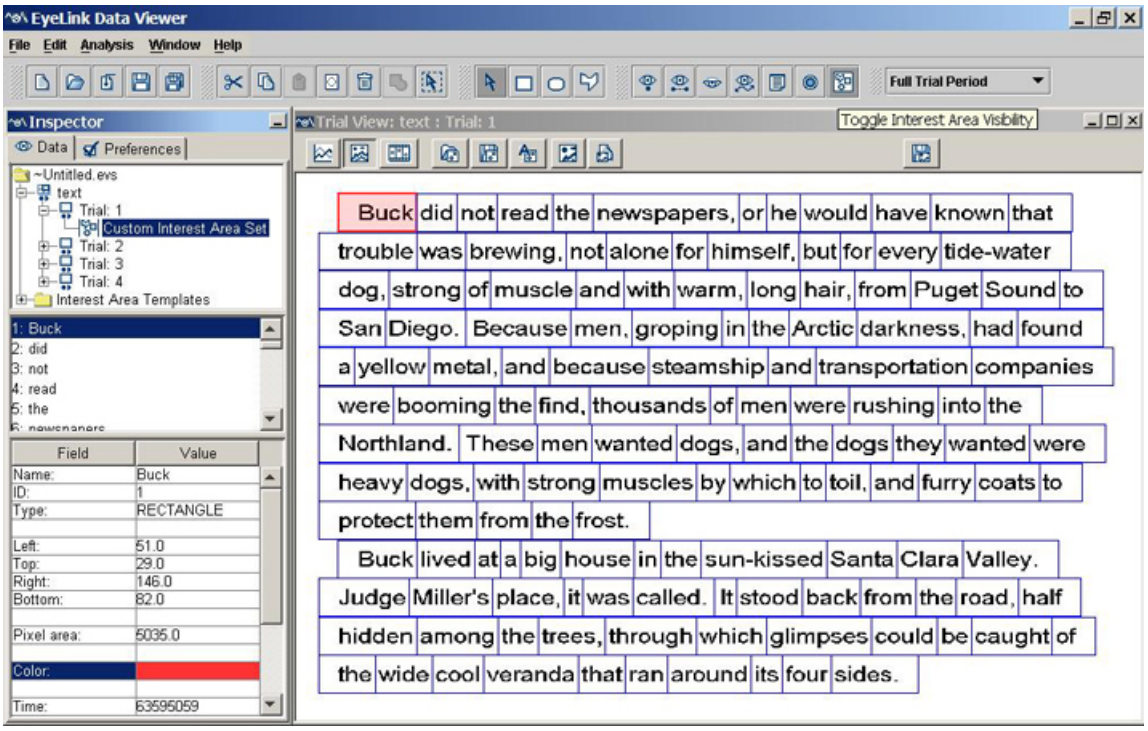

EyeLink Data Viewer
File Edit Analysis Window Help
Full Trial Period
Inspector
Data Preferences
~Untitled.evs
text
Trial: 1
Custom Interest Area Set
Trial: 2
Trial: 3
Trial: 4
Interest Area Templates
1: Buck
2: did
3: not
4: read
5: the
Field Value
Name: Buck
ID: 1
Type: RECTANGLE
Left: 51.0
Top: 29.0
Right: 146.0
Bottom: 82.0
Pixel area: 5035.0
Color:
Time: 63595059
Trial View: text : Trial: 1
Toggle Interest Area Visbility
Buck did not read the newspapers, or he would have known that
trouble was brewing, not alone for himself, but for every tide-water
dog, strong of muscle and with warm, long hair, from Puget Sound to
San Diego. Because men, groping in the Arctic darkness, had found
a yellow metal, and because steamship and transportation companies
were booming the find, thousands of men were rushing into the
Northland. These men wanted dogs, and the dogs they wanted were
heavy dogs, with strong muscles by which to toil, and furry coats to
protect them from the frost.
Buck lived at a big house in the sun-kissed Santa Clara Valley.
Judge Miller's place, it was called. It stood back from the road, half
hidden among the trees, through which glimpses could be caught of
the wide cool veranda that ran around its four sides.

Figure 5-10. Sample Text Display Overlaid with Interest Areas

Field	Contents
Name *	Text of the interest area
ID	Ordinal ID of the interest area
Group	Label of the group to which the current interest area belongs.
Type	Type of interest area (rectangular, elliptic, or freehand)
Left *	X-coordinate of the upper-left corner of the interest area
Top *	Y-coordinate of the upper-left corner of the interest area
Right *	X-coordinate of the lower-right corner of the interest area
Bottom *	Y-coordinate of the lower-right corner of the interest area
Pixel Area	Area of the interest area in pixels.
Color *	To achieve better visibility, the color of the currently selected area interest can be changed by clicking on the color toolbox
Time	EDF file Time when the interest area was created with the '!V IAREA' command during recording. If the interest area was created during the viewing session (manually or from interest area template file), the time value will be -1 and this attribute will not be visible from the property table. The interest area time was useful only when interest periods are created and used (i.e., to filter interest areas based on the current selected

	interest period).
Number Fixations	Total number of fixations within the interest area
Fixation %	Percentage of total fixations in a trial falling within the current interest area
Dwell Time	Total time (in milliseconds) spent on the current interest area
Dwell Time %	Percentage of trial dwell time spent on the current interest area
Sequence (Run)	Count Number of times the interest area was entered and left (i.e., run).

Note: The coordinate information (Left, Top, Right, and Bottom) is available for the rectangular and elliptic interest areas only.

5.8.1 Manually Creating Interest Areas

The visibility of interest areas can be toggled on/off by clicking the Toggle Interest Area Visibility button . To create an interest area:

1) Select the Interest Area shape that you want to create from the Application Desktop toolbar:

	Rectangular Interest Area Shape is active
	Ellipse Interest Area Shape is active
	FreeHand Interest Area Shape is active

For rectangle and elliptic interest area shapes (see Figure 5-10):

2) Hold down the left mouse button in the top-left corner of where you want the interest area to be created.
3) Drag the mouse down to the right until the selection region covers the area that you want to select.
4) Release the mouse button.
5) Enter the name of the Interest Area and press Enter.
6) Repeat steps 2-6 to create more interest areas of the same type. Press the Selection mode icon ( ) from the Application Desktop toolbar to end creating interest areas.

For FreeHand interest area shapes:

2) Double click the left mouse button on the first point of the shape to create.
3) Move the mouse to the second point and double click the mouse again. A line joining the points should be displayed.
4) Repeat step 3 for each point of the freehand shape.

5) Press the ENTER key when you have specified all points you wish to create. The first and last points of the interest area will be joined by the program. Note that you can cancel the creation of a freehand interest area by pressing the ESC key.
6) Enter the name of the Interest Area and press Enter.
7) Repeat steps 2-6 to create more interest areas of the same type. Press the Selection mode icon ( ) from the Application Desktop toolbar to end creating interest areas.

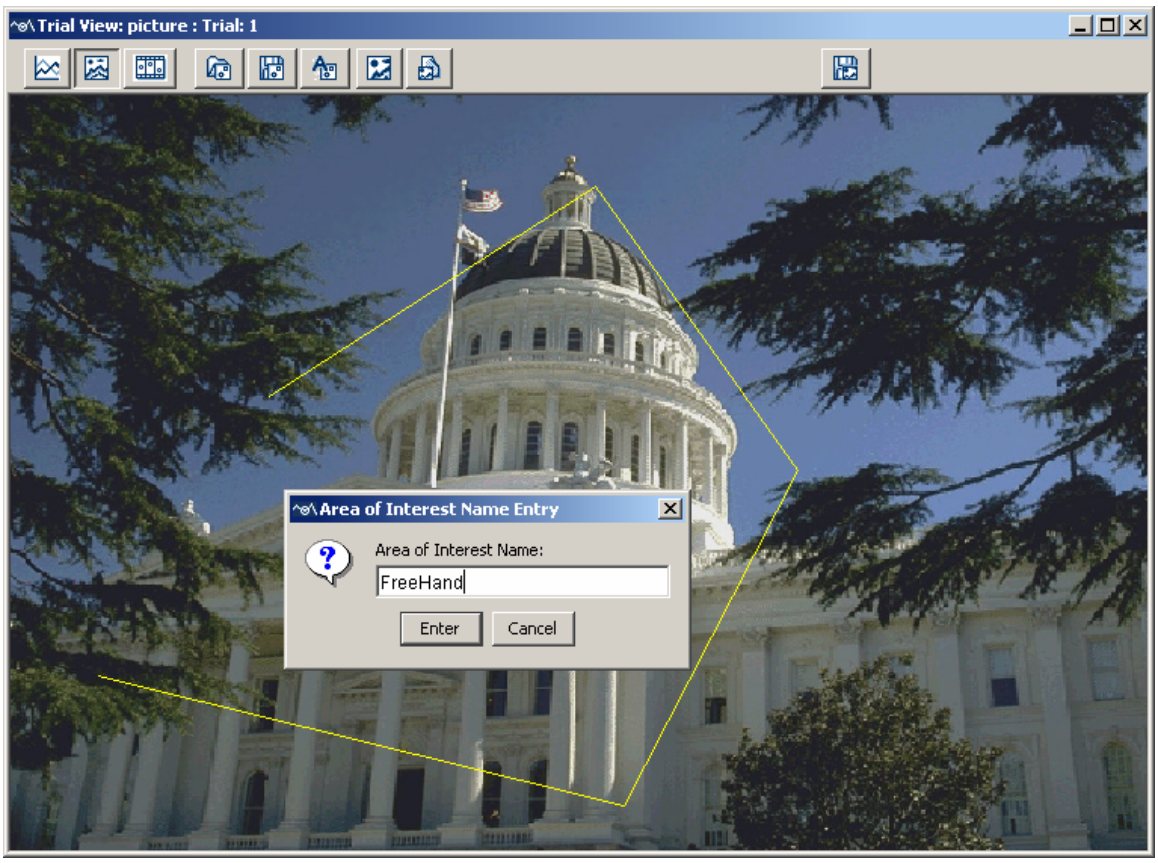


Figure 5-11. Creating a Freehand Interest Area

Several Interest Areas of the same type can be created in a sequence by following the above steps.

5.8.2 Creating Interest Area: Image Segmentation

If a trial bitmap has already been loaded, the Data Viewer can create interest areas for the trial by auto-segmentation. This is done by clicking the "Auto Segment Image to Interest Area" button ( ) in the toolbar of the spatial overlay view window.

Note: Using the auto-segmentation feature will remove all of the pre-existing interest areas for the trial. Auto segmentation is more feasible for those displays in which the

individual items can be easily isolated, such as in reading and visual search studies where a background of a single color is present, but not good for some visual scenes in which the boundaries between individual elements are not clearly defined (see Section 9.7 on preference settings for image segmentation).

5.8.3 Saving Interest Areas

To save interest areas of a trial (to be used as an interest area template or to be imported into another trial):

1) Click the Save the Interest Area Set to Disk button on the spatial overlay window toolbar
2) In the Save dialog box, browse to the directory in which you want to save the interest area.
3) In the File name text box, type in the name for the file.
4) Press Save button.

5.8.4 Importing Interest Area File (for a specific trial)

For each individual trial, interest area can be imported:

4) Click the Import Interest Area File button on the spatial overlay window toolbar
5) In the Load dialog box, browse to the location of the interest area file that you want to import and select it.
6) Click Load.

Note: This operation will delete any existing interest areas in the trial.

5.8.5 Emptying Interest Area Set (for a trial)

To empty the current interest area set for a trial

1) Click the trial whose interest areas are to be emptied in the tree view
2) In the property panel of the trial, find the entry “Interest Area Set” and choose the value of “Empty Interest Area”.

5.8.6 Loading Interest Area Template

If the same interest areas are used for several trials, instead of repeating the procedure of creating interest areas for each individual trial, an interest area template can be loaded to supply the segmentation information for those trials.

To load an interest area template or multiple interest area set files:

1) From the menus, choose:
   File → Import Data → Interest Area Template

2) In the Load dialog box, browse to the location of the interest area file (.ias) that you want to import and select it.
3) Click Load and the tree view panel will be updated.

5.8.7 Using Interest Area Templates

If several trials use the same set of interest areas, an interest area template, if already loaded, can be used (see section 6.1.3 on applying an interest area template to a group of trials). To apply an interest area template,

1) Click on the viewing session icon ( ) and perform trial grouping if necessary.
2) In the tree view panel of the data tab, select the trial/group onto which the interest area template is loaded.
3) In the property panel of a selected trial or trial group, find the entry "Interest Area Set" and select the target interest area template.

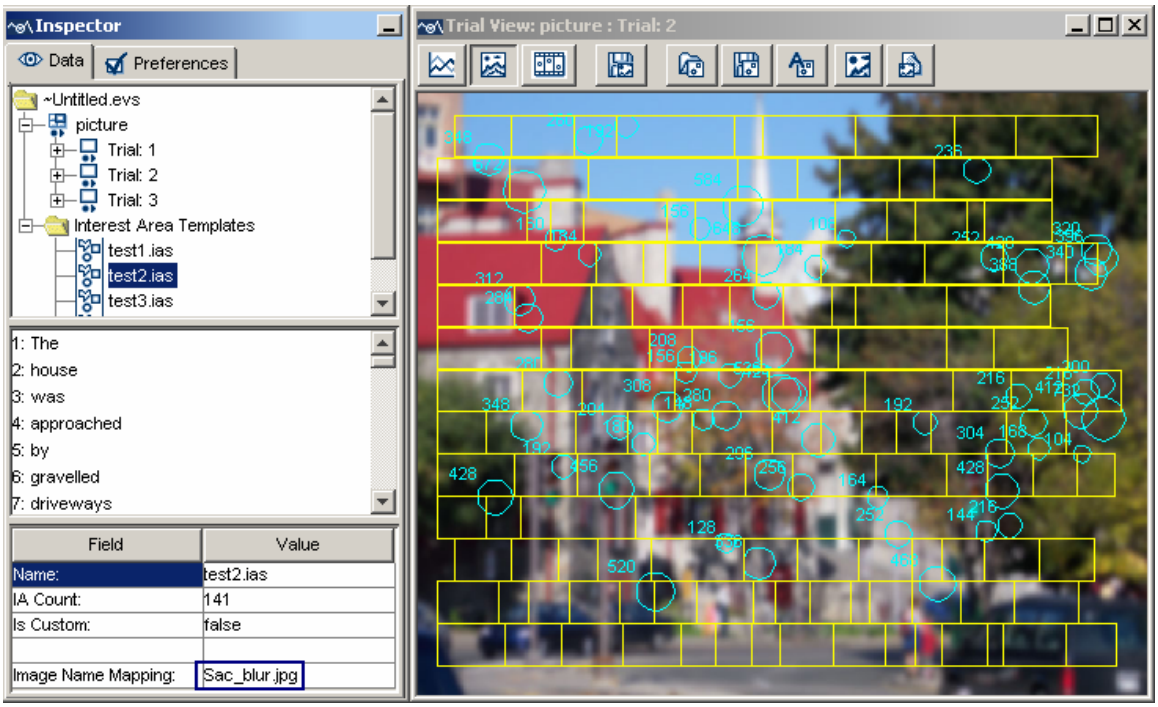
5.8.8 Automatic Trial Image-Interest Area Set Association

If "Auto Select IAS for Trial" property in the "Output/Analysis" preference settings is true, any value in the "Image Name Mapping" field of the interest area set will be used to automatically associate the interest area set to trials. If the last Data Viewer image load command entered in a trial contains an image name that contains the "Image Name mapping" text of the interest area template, then the interest area set is associated with the trial. Please note that the matching is case sensitive, although the "Image Name mapping" text does not need to be the full image path in the trial. If no matching "Image Name Mapping" text was found for the trial in any IAS template, then the default empty interest area set template will be used for the trial.

To illustrate the use of automatic trial image-interest area set association, create a Data Viewer session and load in the sample picture.EDF file (File → Import Data … → EyeLink File(s) …) and segment files test1.ias, test2.ias, test3.ias, and test4.ias (File → Import Data … → Interest Area Template). The second trial of the EDF contains the following image loading command message:

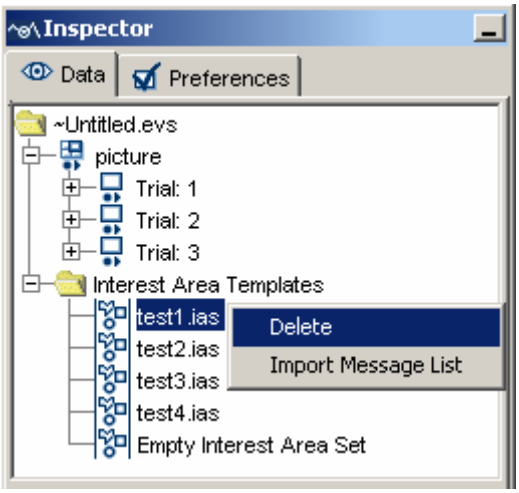
```
MSG   62817663 !V IMGLOAD FILL images\Sac_blur.jpg
```

If the user wants to associate the "test2.ias" to Trial 2, first make sure that the "Auto Select IAS for Trial" property in the "Output/Analysis" preference settings is checked. Click on the test2.ias in the treeview and enter "Sac_blur.jpg" (case sensitive, without quotes) in the "Image Name Mapping" field. Now the interest areas contained in "test2.ias" will be drawn on the Trial View Window for Trial 2.



5.8.9 Deleting Interest Area Templates

Interest area templates can be deleted from IA template list. In the Treeview panel of the Inspector window, locate the "Interest Area Templates" folder where all of the interest area templates are loaded. Select the target interest area template from the list, click the right mouse button, and select "Delete". If the deleted interest area template is being used by a trial, the "Interest Area Set" property of that trial will be set to "Empty Interest Area Set".



5.8.10 Selecting Interest Areas

To select an interest area, place the mouse cursor over the interest area and click the left mouse button. The interest area is highlighted after selection. To select more than one

interest area, hold the CTRL key down and select the target area, until all desired interest areas are selected. If all interest areas in the trial are to be selected, simply click the Select All Visible Item button on the toolbar (or click the right mouse button and select "Select All").

Note: If there are eye movement events within the interest area to be selected, clicking on the interest area will likely select the eye movement events instead. To make a more precise IA selection, click on the "Custom Interest Area Set" node of the trial in the tree view and select the interest areas from the list panel. Alternatively, you can toggle off the eye movement events first, make the interest area selection, and then toggle the eye movement events back on.

5.8.11 Moving an Interest Area

An interest area can be moved by following these steps:

1) Put the mouse cursor over the Interest Area
2) Hold the ALT key down.
3) Press the left mouse button
4) Drag the IA to the desired location
5) Release the mouse button.

5.8.12 Resizing Rectangular and Elliptic Interest Areas

A rectangular or elliptic interest area can be resized by following these steps:

1) Hold the ALT key down.
2) Place the mouse over the border to be dragged (the arrow cursor changes into a sizing cursor)
3) Press the left mouse button and drag the border to the desired location
4) Release the mouse button.

To carry out a more precise adjustment for a rectangular or elliptic interest area:

1) Select the interest area to move or adjust
2) In the property panel of the interest area, select the entry for "Left" and type in the desired x-coordinate of upper-left corner
3) Select the entry for "Top" and type in the desired y-coordinate of upper-left corner
4) Select the entry for "Right" and type in the desired x-coordinate of bottom-right corner
5) Select the entry for "Bottom" and type in the desired y-coordinate of bottom-right corner.

5.8.13 Resizing Freehand Interest Areas

A freehand interest area can be resized by following these steps:

1) Select the interest area
2) Hold the ALT key down.
3) Place the mouse over the vertex to be dragged (the arrow cursor changes into a hand cursor)
4) Press the left mouse button and drag the vertex to the desired location
5) Release the mouse button.

5.8.14 Deleting Interest Areas

To delete interest areas:

1) To delete interest areas without removing any events falling within, first toggle off all event visibility.
2) Select the interest areas
3) Press the right mouse button
4) Select the Delete option from the popup menu.
5) Confirm that the IAs should be deleted.

Tip: Interest areas can also be deleted by clicking the Delete Selected Items button or the Cut Selected Item button on the desktop toolbar.

5.8.15 Splitting Interest Areas

Rectangular and elliptic interest areas can be split either horizontally or vertically. You can split many interest areas at one time by selecting multiple IAs. To split all selected IAs:

1) Select the IA(s) to split.
2) Press the right mouse button
3) Select “Split” from the popup menu

5.8.16 Merging Interest Areas

Neighboring rectangular interest areas can also be merged. To do that:

1) Click "Toggle Fixation Event Visibility" button on the trial view window toolbar so that the fixation events will not be merged.
2) Press CTRL key to select the intended interest areas;
3) Click right mouse button to bring up a popup menu, select "Merge" from the list.

6 Exporting Data

One of the ultimate goals of the EyeLink Data Viewer is to extract useful eye-movement information and export the data to a text file that can be processed by most statistical analysis software. Currently, the Data Viewer supports five kinds of outputs: trial reports, fixation reports, saccade reports, interest area reports, sample output reports, and recording event sequence data.

6.1 Managing Trial Variables

The Trial Variable Manager (Figure 6-1) and the Trial Variable Value Editor (Figure 6-2) allow the user to review the currently available variables, to assign a default value for the variables, to create or remove variables, and to change the variable values on a trial-by-trial basis.

6.1.1 Trial Variable Manager

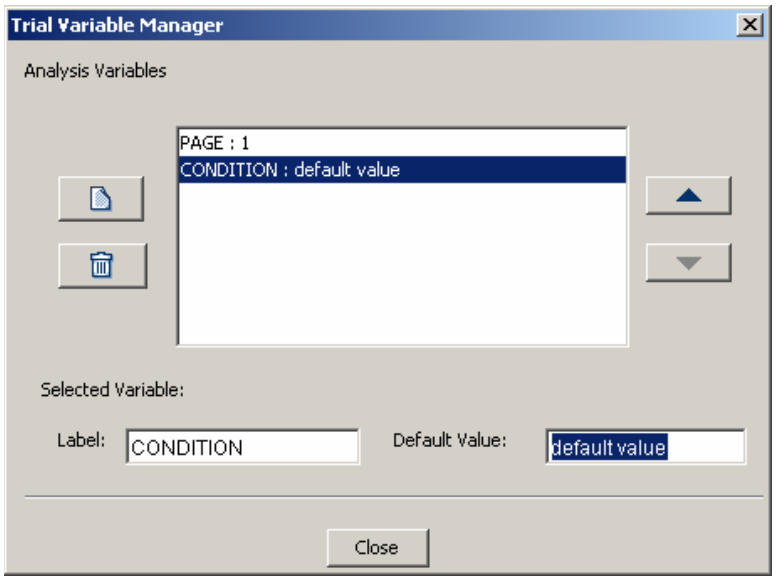


Figure 6-1. Trial Variable Manager

The Trial Variable Manager Dialog, activated by pressing Analysis → Trial Variable Manager from the menus, lists the filename (DATA_FILE) and other variables imported from the EDF file, if the TRIAL_VAR_LABELS command is used (PAGE in this case; see Section 7.2.1 on how to define new trial variable labels).

To assign a default value to one variable, click on the variable and type in the default value in the Default Value edit box (Be sure to press Enter to register the change you made). To create a new variable, click the button on the left. A new variable ("label")

with a default value ("default value") will appear. Select the variable and change its label and default value in the two edit boxes (DO NOT include quotes for text strings). To remove one variable, select it in the list and click the delete button .

Sometimes, the order in which the variables are listed is important. This is especially true when you want to match the variables created with the Trial Variable Manager and the values read from the command messages in EDF file (e.g., TRIAL_VAR_DATA, TRIALID; see the preference settings on data loading). To do that, simply select the variable and use the or button to move it to the desired position.

6.1.2 Trial Variable Value Editor

The variables and their values can be viewed and edited in the Trial Variable Value Editor dialog box.

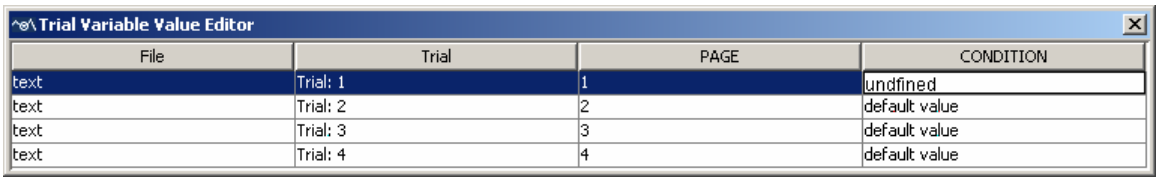


Figure 6-2. Trial Variable Value Editor Dialog

To activate the dialog box, from the menus, choose:

Analysis → Trial Variable Value Editor

The top-row of the dialog box lists the filename, variables imported from the EDF file, as well as variables created by the Trial Variable Manager. The following rows list the corresponding values for the variables in each individual trial. To change the value for a particular cell, double click on the current value, type in the new value (DO NOT include quotes for text strings), and press Enter to register the change. (Note, presumably, the user would load EDF files of the same experiment with the same condition labels, into one viewing session. Loading EDF files containing different condition labels from each other may result in some unexpected findings.)

6.1.3 Trial Grouping

Trial condition variables are important for identifying one specific trial or grouping trials tested under the same experimental condition. Thus, instead of going through each of the individual trials, a trial grouping mechanism can be applied to manipulate those trials collectively. For example, practice trials can be removed from the viewing session in a batch, interest area templates can be applied to those trials using the same search display,

and potentially, a “landscape” view can be created for the same display image with data collected from several subjects to identify the informative parts of the display.

By default, the Data Viewer group all of the trial by data file. To regroup trials within a viewing session, select the viewing session icon ( ), click the right mouse button, and choose the “Trial Grouping” option. In the following “Edit Trial Grouping” dialog, choose the variable with which the grouping should be performed and press the “Regroup” button (see the left panel of Figure 6-3). Multiple grouping variables can be selected or de-selected by using the control key; if no grouping variable is chosen, grouping will be performed based on the data file each trial belongs to. Once grouping is performed, the trials will be listed by the conditions of the grouping variables selected (see the right panel of Figure 6-3). The property panel of each group lists the label (values of the grouping variables), total number of trials, and configurable interest area information for the group. Thus, the user can potentially apply an interest area template to all trials in the group (see section 5.8.7 Using Interest Area Templates).

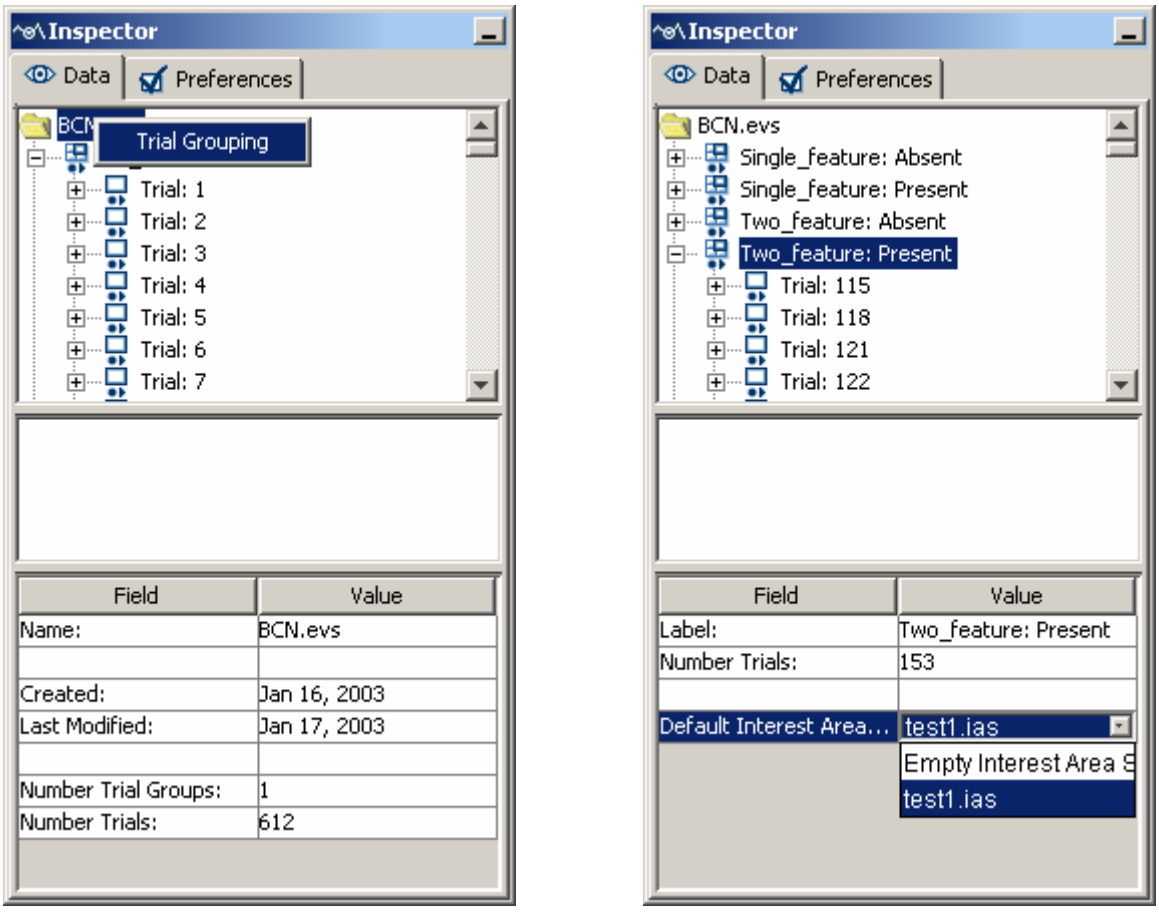


Figure 6-3. Applying Trial Grouping by a Trial Condition Variable and Setting Interest Area Template for a Group of Trials.

6.2 Fixation Map

The EyeLink Data Viewer also allows the user to create a "landscape" view for a trial or for a group of trials with the same background image to visually identify the informative parts of the display. To create a Fixation map for a single trial, select the trial node ( ) in the top-panel of the inspector window, click the right mouse button and select "Create Fixation Map" option. To create a Fixation map for a group of trials, select the group node ( ). Click the right mouse button and select "Create Fixation Map" option (if no common image has been applied to the trials yet, select "Select Trial Background Image" option before creating a Fixation map). Section 9.3 lists all of the preference settings related to creating Fixation map.

Figure 6-4. Sample Fixation Map

6.3 Managing Reaction Time Definitions

Another important application of the trial condition variables is for managing reaction-time definitions for all the trials in the same experimental condition. A typical trial recording could be ended in several ways, such as a button response, a saccade event, a fixation event, or a special message. To obtain an accurate reaction time (RT) measure, the EyeLink Data Viewer relies on a set of reaction time definitions to parse the start and

end events for RT calculation. The reaction time manager allows the user to configure the way in which the trial starts and ends for each condition of the experimental design. Once a set of RT definitions has been created and initialized, the RT start and end event information is available in both the trial view window and the inspector window.

6.3.1 Reaction Time Manager

The Reaction Time Manager is used to create, edit, or delete reaction time definitions for different experimental conditions. The user can set parameters of a trial end event and specify condition values that must be matched for the RT definition to be applied to a given trial.

To configure reaction time definition,

1) From the menus, choose:
   Analysis → Reaction Time Manager

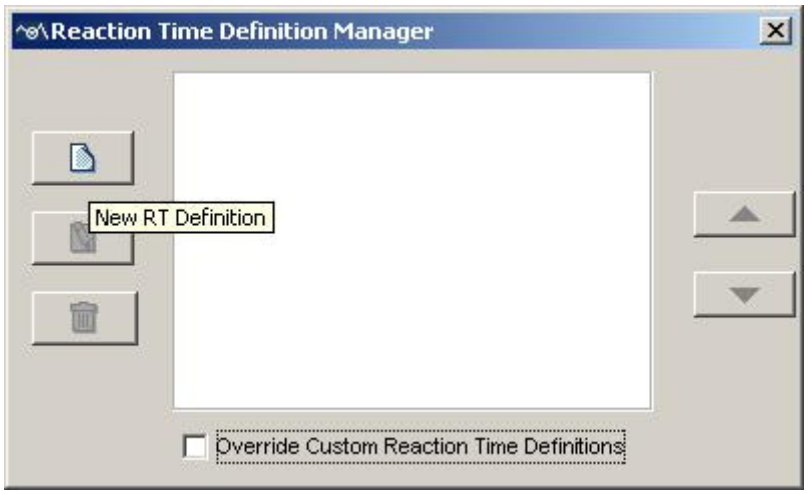


Figure 6-5. Reaction Time Definition Manager

In the reaction time manager dialog (see Figure 6-5), the user can create a new reaction time (RT) definition by clicking the new button on the left, edit an existing RT definition by clicking on the button, and remove an RT definition by clicking on the button.

Users who have already had custom reaction time messages defined in the EDF file need to decide whether the customer RT messages or the RT definitions created here should take precedence when both of them are applicable for a particular trial. If "Override Custom Reaction time definitions" box is checked, the new RT definitions created through the Reaction Time Manager will take precedence; otherwise, the custom RT messages written in the EDF file will be used.

2) Click on the button. In the Reaction Time Definition Editor dialog (General Tab; see Figure 6-6)
    a. Enter a label for the current RT definition in the Label edit box;
    b. Select the type of RT end event from the Type combo box;
    c. In the Trial Condition Qualifiers group box, select the trial condition variables and enter the intended values for the current RT definition (DO NOT include quotes for text strings).

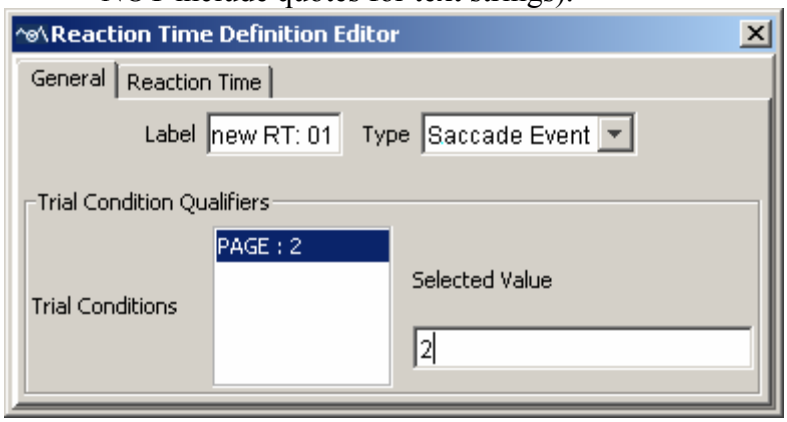


Figure 6-6. Reaction Time Definition Editor (General Tab)

3) Select the Reaction Time tab (see Figure 6-7).

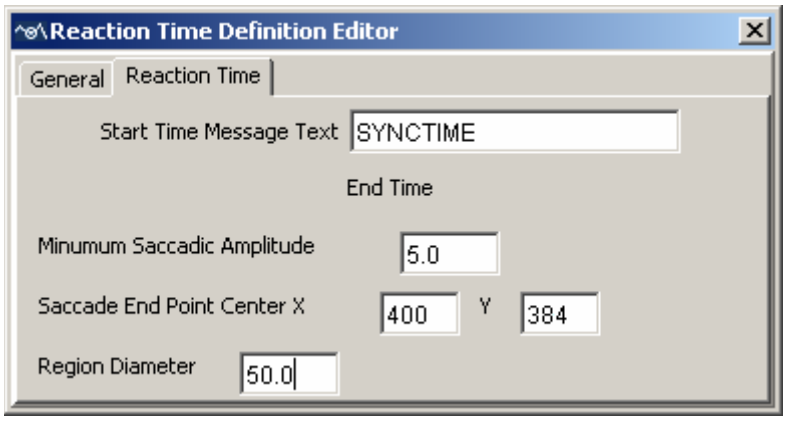


Figure 6-7. Reaction Time Definition Editor (Reaction Time Tab)

The layout of the Reaction Time tab depends on the type of end event you selected in the General tab. One common feature though, is the configuration of the start time message. In the Start Time Message Text edit box, type in the intended message string (the default is "SYNCTIME");

Button Event:

This will treat a particular button press/release as the reaction time end event. Select the intended button ID from the Button Number combo box and choose the button state (button press or release).

Message Event:
This will treat the first occurrence of a matching message as the end event for reaction time calculation. In the "Message Text" edit box, type in the message string (DO NOT include quotes for text strings).

Fixation Event:
This will end the trial by the appearance of a specific fixation. In the edit boxes, fill in the minimum fixation duration (in millisecond) required, as well as the *xy* coordinates of the center of the fixation region and the diameter of the region.

Saccade Event:
This will end the trial by the occurrence of a specific saccade. Fill in the minimum saccadic amplitude (in degrees of visual angle) required, as well as the *xy* coordinates of the region center and the diameter of the saccade region.

4) Once all the desired RT definitions have been set, arrange the order of the definitions by using the ▲ and ▼ buttons in the Reaction Time Definition Manager dialog. This operation is important only when more than one RT definition can be met for a single trial. Always put specific definitions before general ones.

5) Close the Reaction Time Manager dialog. This will apply the reaction definitions to all trials. If there are lots of trials in a viewing session, this may take some time to finish.

6) If the user thinks that the current RT definitions are not appropriate, she/he can remove them by clicking on the "Delete" button on the Reaction Time Definition Manager dialog box.

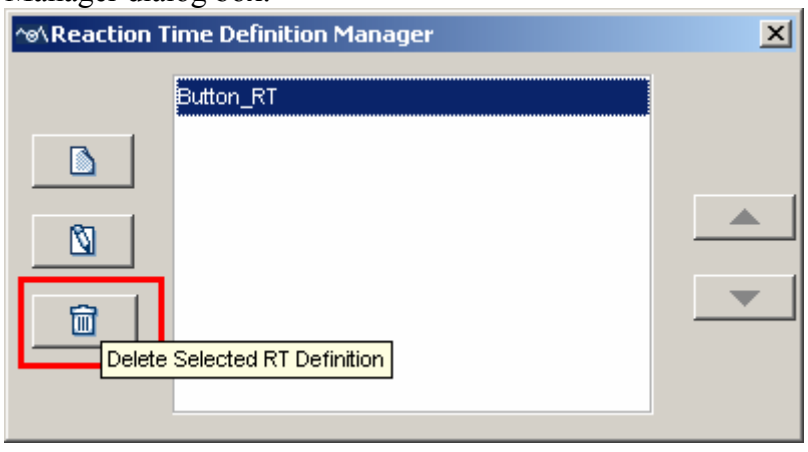


Figure 6-8. Deleting Reaction Time Definitions

6.3.2 Viewing Reaction Time Information

If the reaction time events are initialized, such information is available for viewing in trial view window (see Figure 6-9). In the spatial overlay view, a red RT symbol is displayed near the end event. In the temporal graph view, a green line is drawn at the time when the start time message is presented and a red line is drawn at the time when the end event occurs (to see these graphics, make sure that the Display RT Graphics field in the General Trial View Preferences is checked; see section 9.5).

In the event list of the Inspector window, select the end event that meets the reaction time definition for the selected trial. The RT End Event field of that event is automatically checked. This field will be unchecked and reaction time calculation will be updated if the user decides to choose another event as the RT end event by checking the same field of the newly selected event.

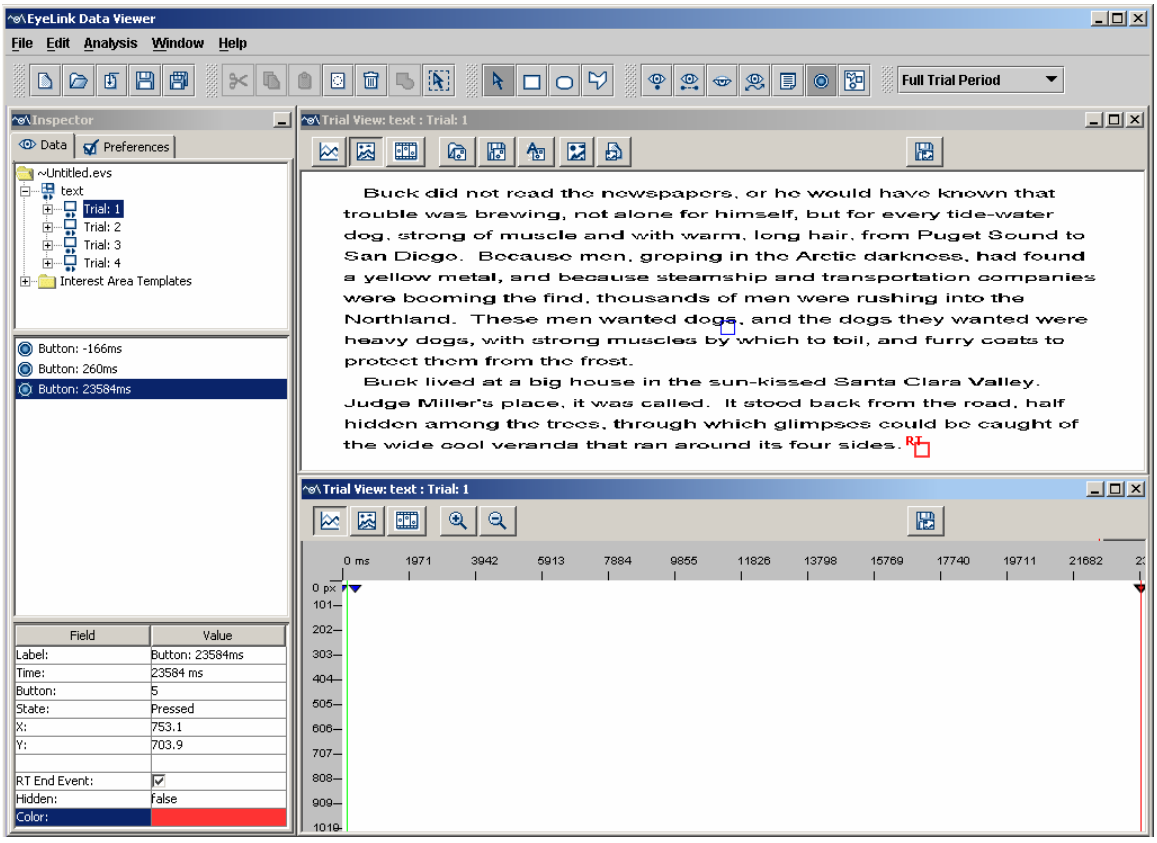

EyeLink Data Viewer
File Edit Analysis Window Help
Full Trial Period
Inspector
Data Preferences
~Untitled.evs
text
Trial: 1
Trial: 2
Trial: 3
Trial: 4
Interest Area Templates
Button: -166ms
Button: 260ms
Button: 23584ms
Field Value
Label: Button: 23584ms
Time: 23584 ms
Button: 5
State: Pressed
X: 753.1
Y: 703.9
RT End Event:
Hidden: False
Color:
Trial View: text : Trial: 1
Buck did not read the newspapers, or he would have known that trouble was brewing, not alone for himself, but for every tide-water dog, strong of muscle and with warm, long hair, from Puget Sound to San Diego. Because men, groping in the Arctic darkness, had found a yellow metal, and because steamship and transportation companies were booming the find, thousands of men were rushing into the Northland. These men wanted dogs, and the dogs they wanted were heavy dogs, with strong muscles by which to toil, and furry coats to protect them from the frost.
Buck lived at a big house in the sun-kissed Santa Clara Valley. Judge Miller's place, it was called. It stood back from the road, half hidden among the trees, through which glimpses could be caught of the wide cool veranda that ran around its four sides.
RT
Trial View: text : Trial: 1
0 ms 1971 3942 5913 7884 9855 11826 13798 15769 17740 19711 21682
0 px 101 202 303 404 505 606 707 808 909 1010

Figure 6-9. Reaction Time Graphics in Both the Spatial Overlay View and the Temporal Graph View of the Trial View Window

6.4 Interest Periods

Besides the above-mentioned reaction-time definitions, the user may also selectively view and perform analysis on data within a specific period of time within a trial (Interest Period). For example, the user may want to examine the eye data between two important markup messages; for a trial with multi-page manipulation, analysis may be performed separately for the period of each page presentation. The EyeLink Data viewer allows the user to create interest periods based on messages, button events, or duration. To do that, when programming an experiment, the user should mark up possible interest periods with messages or other important events such as button presses. If different images were shown within different interest period, the user should also make sure that messages used to load images, text, or draw simple graphics be recorded with the scope of the intended interest period.

6.4.1 Creating Interest Periods

To create an interest period,

1) Click the "Interest Period List" combo box at the far-right hand of the application menu bar and select the "Edit …".
2) Similar to the reaction time manager dialog (see Figure 6-10), the user can create a new interest period by clicking the new button on the left, edit an existing interest period by clicking on the button, and remove an interest period by clicking on the button.

Click on the new button. In the Interest Period Editor dialog (General Tab, see Figure 6-10), enter a label for the current interest period in the label edit box and select the type of interest period end event (Button, Message, or Duration-based) from the Type combo box.

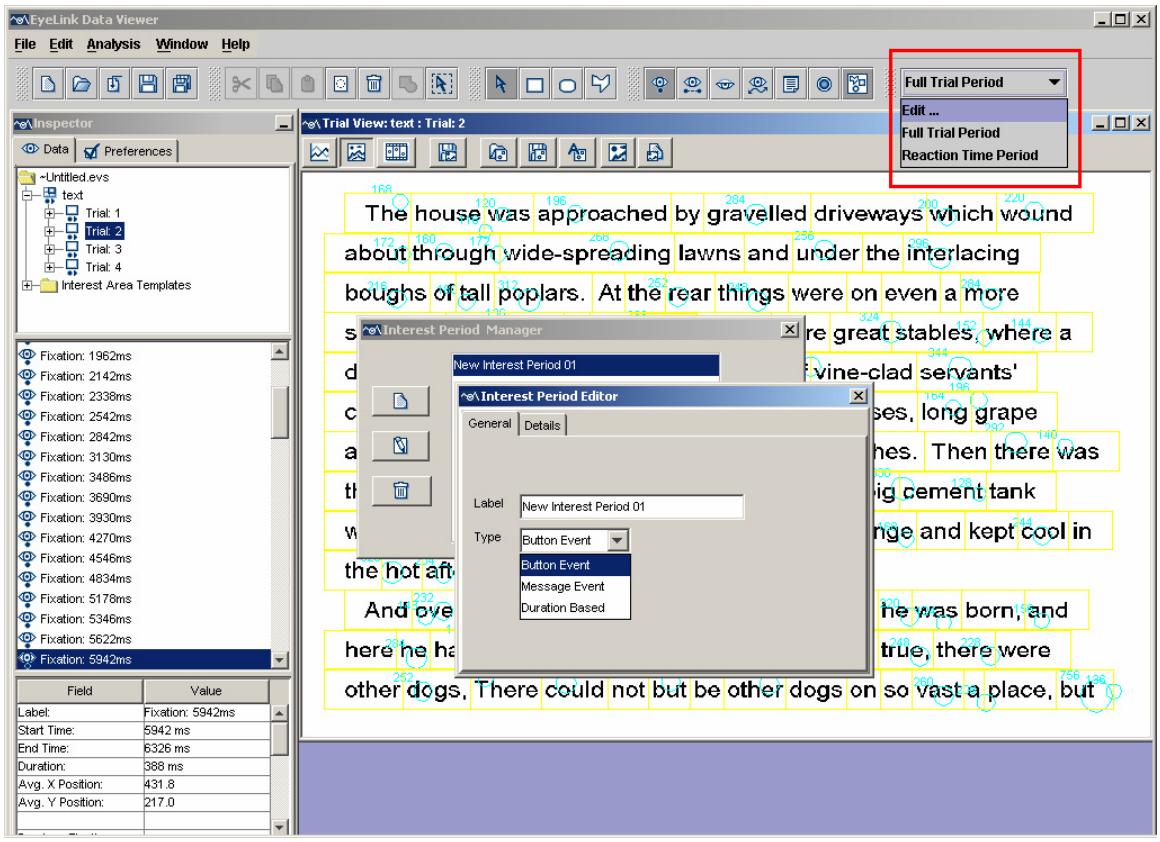


Figure 6-10. Interest Period Editor (General Tab)

3) Select the Details Tab (see Figure 6-11).

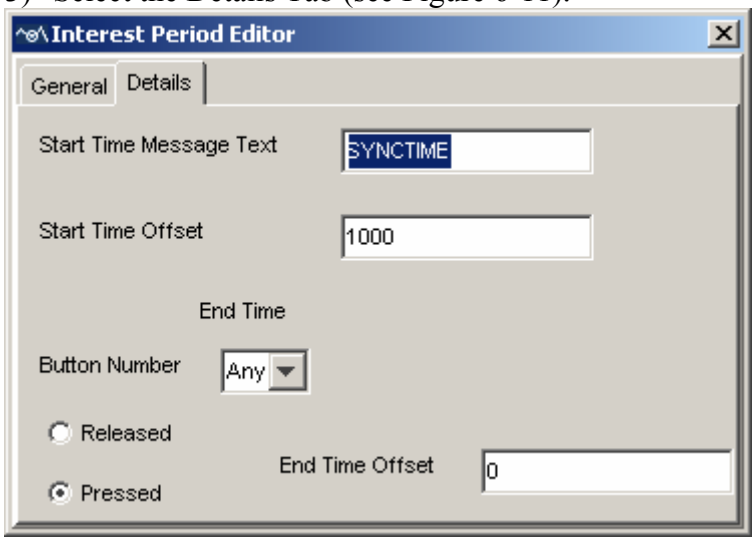


Figure 6-11. Interest Period Editor (Details Tab).

Similar to the reaction time definition, the layout of the Details tab depends on the type of the end event the user selected in the General Tab.

Button Event:
This will treat a particular button press/release as the interest period end event. In the Start Time Message Text edit box, enter the message string (case-sensitive; DO NOT include quotes for text strings). Select the intended button ID from the Button Number combo box and choose the desired button state (button pressed or released). The user can also specify a time offset (0 or a positive number in milliseconds) for the start time and end time so that the interest period does not start or end right on the time of message and/or button event.

Message Event:
This will treat the first occurrence of a matching message as the end event for the interest period. Enter the desire message strings for both the Start Time and End Time Message Text edit boxes (case sensitive, with no quotes for text strings). The user can also set a time offset (0 or a positive number, in milliseconds) for the start time and end time. Please note that when using this option, the interest period end message must be different from the start message; otherwise, the user should use a duration-based interest period instead (see below).

Duration Based:
The interest period can also be based on a duration following the detection of the start message (e.g., 10 seconds following the "SYNCTIME" message). The user needs to specify a message string (case-sensitive; DO NOT include quotes for text strings) in the Start Time Message Text edit box. The user can also specify an optional offset time value so that the interest period does not start right on the message time. In the "Duration" edit box, enter the desired duration (a positive number in milliseconds) of the interest period.

4) Close the Interest Period Editor dialog. This will initialize the interest period for all trials.

6.4.2 Using Interest Period

The newly-created interest periods are added to the interest period list, along with the default interest periods – "Full Trial Period" and "Reaction Time Period". The user can navigate between different interest periods by selecting the desired interest period from the list. For each interest period, only those events falling within that period are shown in the spatial overlay, temporal graph views, and in the event list of the inspector window. In addition, for all of the following output analyses (trial, fixation, saccade, interest and recording sequence outputs), only those events and data within the selected interest period (custom-defined interest period, or the default – "Full Trial Period" or "Reaction Time Period") are exported.

6.5 Trial Report

Trial report summarizes the performance of individual trials. Before trying to obtain a trial report, make sure that you have completed the reaction time definition and initialized the reaction time events.

6.5.1 Obtaining a Trial Report

To obtain a trial report (Figure 6-12),

1) From the menus, choose:
   Analysis → Report → Trial Report
1) Select the variables in the list of available output variables (left panel) and press ">>" to enter the variables into the list of selected output variables.
2) To remove one variable from the output list, simply select that variable and press "<<".
3) To change the order in which the variables are listed, simply select one variable and use the ▲ or ▼ button to move it to the desired position. Repeat this step until all variables are in the right position.
4) Once all the desired variables have been entered into the output list, press NEXT button.
5) In the Export dialog box, browse to the directory in which you want to save the output report.
6) In the File name text box, type in the name for the document. Note, if the output report name does not contain an extension (i.e., ".***", where *** are any 3 characters), the file name is appended with a ".txt" by default.
7) Press Export button.

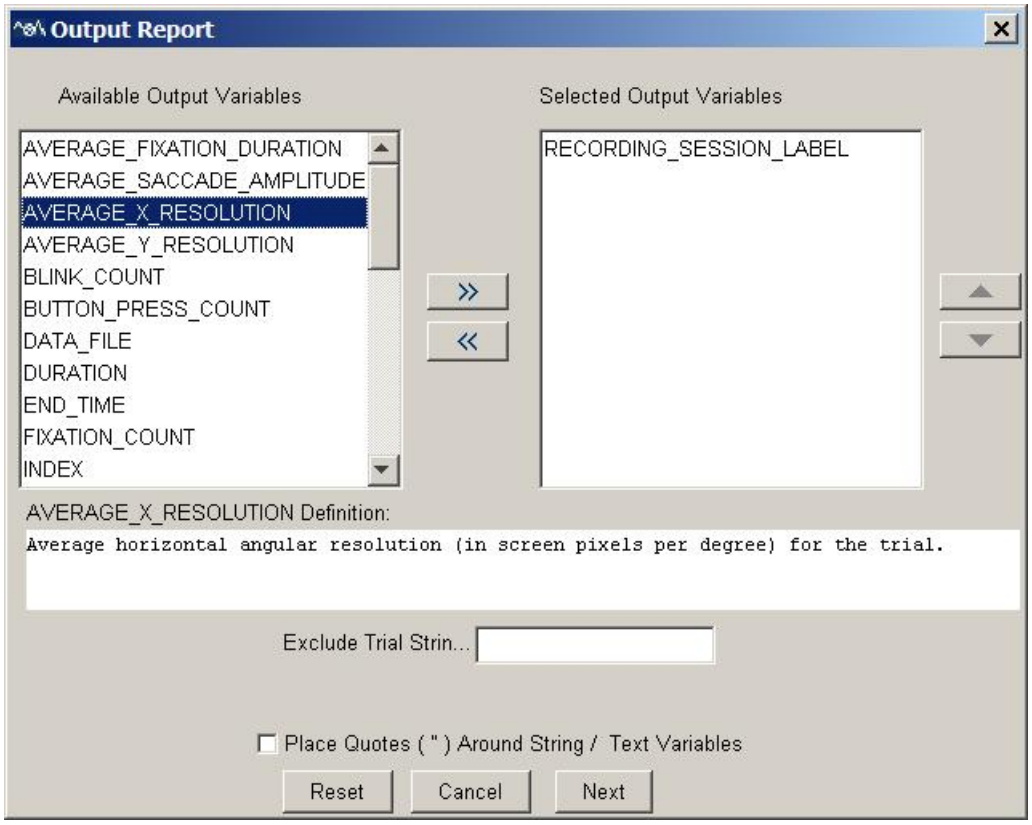


Figure 6-12. Selecting Output Variables in a Trial Report

6.5.2 Variables in the Trial Report

The following variables are listed in the trial report:

Field	Contents
RECORDING_SESSION_LABEL	Label of the data file
* AVERAGE_FIXATION _DURATION	Average duration (in milliseconds) of all selected fixations in the trial
* AVERAGE_SACCADE _AMPLITUDE	Average size (in degrees of visual angle) of all selected saccades in the trial
AVERAGE_X/Y_RESOLUTION	Average horizontal/vertical angular resolution (in screen pixels per degree) for the trial
* BLINK_COUNT	Total number of blinks in the trial
* BUTTON_PRESS_COUNT	Total number of button presses in the trial
DATA_FILE	File name of the data
DURATION	Duration of the trial recording between the "START" message and the "END" message
END_TIME	Timestamp when the trial recording ends (in milliseconds since EyeLink tracker was activated)

EYE_USED	Which eye's data (LEFT or RIGHT) is used to create this report?
* FIXATION_COUNT	Total number of fixations in the trial
INDEX	Sequential order of the trial in the recording
INTEREST_AREA_SET	Setting of the interest area ("Custom Interest Area Set" if interest areas are loaded/created and "Empty Interest Area Set" if not)
* IP_DURATION	Duration of the interest period in milliseconds.
* IP_END_TIME	End time (in milliseconds since EyeLink tracker was activated) of the interest period.
* IP_START_TIME	Start time (in milliseconds since EyeLink tracker was activated) of the interest period.
* MESSAGE_COUNT	Total number of messages in the trial
* PUPIL_SIZE_MAX	Maximum pupil size in arbitrary units (Typical pupil area is 800 to 2000 units while pupil diameter is in the range of 1800-3000 units). Note that PUPIL_SIZE_MAX, PUPIL_SIZE_MEAN, and PUPIL_SIZE_MIN fields will output a missing value if samples are not loaded into a viewing session (see Data Loading Preferences).
* PUPIL_SIZE_MEAN	Average pupil size in arbitrary units.
* PUPIL_SIZE_MIN	Minimum pupil size in arbitrary units.
*PUPIL_SIZE_MAX_TIME	EDF Time of the sample with maximum pupil size. Note that this field will output a missing value if samples are not loaded into a viewing session (see Data Loading Preferences).
*PUPIL_SIZE_MAX_X	X position at PUPIL_SIZE_MAX_TIME.
*PUPIL_SIZE_MAX_Y	Y position at PUPIL_SIZE_MAX_TIME.
¶ REACTION_TIME	Configurable response time determined by the Reaction Time Definition associated with the trial. This variable returns a '.' if the trial does not have an RT end event.
¶ RT_DEFINITION_LABEL	Label of the RT definition (".” if undefined). "CUSTOM_RT" if the RT definition is a custom one (see Section 7.4 on reaction-time definitions).
¶RT_EVENT_BUTTON_ID	If the RT end event is the press/release of a button, records the button ID; otherwise, records ".”
¶ RT_EVENT_END_TIME	End time (in milliseconds since EyeLink tracker was activated) of the end event. If end event is not an eye event (fixation or saccade event), this variable is equal to RT_EVENT_START_TIME.
¶ RT_EVENT_INDEX	Sequential order of the end event; -1 when

	NO_MATCH. Index is relative to a given event type.
¶ RT_EVENT_MESSAGE_TEXT	Records the message text of the end event. If the end event is not a message event, records "."
¶ RT_EVENT_POSITION_X/Y	Records the X/Y coordinates of the fixation or saccade end event and sets "." for a button or message end event.
¶ RT_EVENT_START_TIME	Start time (in milliseconds since EyeLink tracker was activated) of the end event.
¶ RT_EVENT_TYPE	The way in which the trial is ended (BUTTON, FIXATION, SACCADE, MESSAGE, or NO_MATCH)
¶ RT_START_TIME	Start time (in milliseconds since EyeLink tracker was activated) of RT definition for a trial.
* RUN_COUNT	Total runs of fixations in the trial (two consecutive fixations in the same interest area belong to the same run).
* SACCADE_COUNT	Total number of saccades in the trial
* SAMPLE_COUNT	Total number of samples in the trial
START_TIME	Timestamp when the trial recording starts (in milliseconds since EyeLink tracker was activated)
TRIAL_LABEL	Label of the trial

Besides these default variables, additional trial variables will be listed if they have been defined in the EDF file (see section 7.2.1 on trial variable labels) or created during the viewing session (see section 6.1.1 on trial variable manager).

6.5.3 Using Trial Report

Please note that in the above table, outputs for all of the variables marked with an "*"will change as different interest period filters are used. For example, the output for a trial filtered by a reaction time period may be different from a full-trial output, as the former only include a subset of the full-trial data in the report. Therefore, please make sure that you have the right setting for the interest period filter when creating you own reports (see figure below; see also 6.4.2). In those trials with no reaction time defined, missing values (".") will be recorded for those variables marked with a "¶" sign. Please also note that event counts only factor in visible events. If an event is hidden and not visible, it will not contribute to event counts. If hidden events are visible, then they will apply to event counts.

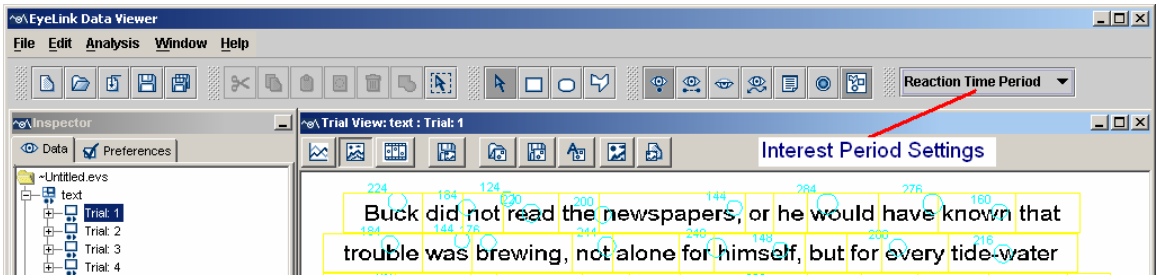


Figure 6-13. Using Interest Period for Event Filtering

Three time periods have been used in a trial output report: 1) recording period, 2) reaction-time period, and 3) interest period. The recording period (START_TIME, END_TIME, and DURATION) of a trial starts from the "START" message in the EDF file and ends on the "END" message. This is fixed for a recording trial, regardless how the user set the interest period filters.

If a valid reaction time definition is found for one trial, the RT_START_TIME is the time of the RT start message (e.g., time of "SYNCTIME" message), RT_EVENT_END_TIME, and RT_EVENT_START_TIME are the start and end time of the RT event (fixation, saccade, button, or message). Reaction time (REACTION_TIME) is calculated as the difference between RT_START_TIME and RT_EVENT_START_TIME. Please note that the RT_EVENT_END_TIME and RT_EVENT_START_TIME will be the same when a button or message is used as the RT end event but will be different when a fixation or saccade is defined as the end event. If the user does not create a reaction time definition or no valid reaction time definition is found for one trial, REACTION_TIME, RT_EVENT_END_TIME, and RT_EVENT_START_TIME, and other variables related to reaction-time definition will have missing values (".") whereas RT_START_TIME will be the same as the trial recording start time (START_TIME).

The interest period variables will have different values depending on the settings used in the interest period filter (see Figure 6-13). If the interest period filter is set to "Full Trial Period", the start (IP_START_TIME), end (IP_END_TIME), and duration (IP_DURATION) of the interest period will be same as those for the recording period (i.e., START_TIME, END_TIME, and DURATION). If the interest period filter is set to "Reaction Time Period", the start, end, and duration of the interest period will be same as those for the reaction time period. If the user has created her/his own interest period (see section 6.4.1) and that interest period is used to filter events, the output report will only do summary statistics (variables marked with "*" in the above table) for those events falling within that period.

6.5.4 Configuring the Trial Report

The Data Viewer also allows the user to configure the trial report (similarly the fixation report, saccade report, and the interest area report). The user can exclude some trials by entering a string in the "Exclude Trial String" edit box. This string should be one message or part of a message within the scope of the trial recording (see section 7.1 on defining the start and end of a trial) that uniquely defines that subset of trials to be excluded. In addition, to enable correct loading of string/text variables in some statistics software, the Viewer also has an option of adding a pair of quotation marks for such variables.

6.6 Fixation Report

Fixation report creates a columnar output of fixation events. Each row of the report represents a fixation event. Depending on the variables selected for output, each row can contain information on the previous fixation and/or saccade, as well as the next fixation and/or saccade.

6.6.1 Obtaining a Fixation Report

To obtain a fixation report, follow the same procedure as in obtaining the trial report, except from the menus, choose:

Analysis → Report → Fixation Report

6.6.2 Variables in the Fixation Report

Currently, the fixation report includes the following variables:

Field	Contents
RECORDING_SESSION_LABEL	Label of the data file
CURRENT_FIX_ADJUSTED	Whether the current fixation has been adjusted manually
CURRENT_FIX_BLINK _AROUND	Whether there is a blink preceding or following the current fixation. Possible values are "AFTER" (a blink follows the current fixation), "BEFORE" (a blink precedes the current fixation), "BOTH" (the current fixation is flanked by a preceding and a following blink), or "NONE" (no blink appears around the current fixation).
CURRENT_FIX_BUTTON_0_PR ESS … CURRENT_FIX_BUTTON_8_PR ESS	Time from trial start if a specific button (0 - 8) has been pressed during or after fixation. If no button press is made from the start of the current fixation to the start of next fixation, missing value "." is assigned.
CURRENT_FIX_DURATION	Duration of the current fixation

* CURRENT_FIX_END	Trial time when the current fixation ends
* CURRENT_FIX_END_OTHER	Trial time when the current fixation ends (on the other eye in a binocular recording).
CURRENT_FIX_INDEX	Ordinal sequence of the current fixation in the trial
CURRENT_FIX_INTEREST _AREAS	Interest area in which the current fixation falls.
CURRENT_FIX_INTEREST_ARE A_DWELL_TIME	Total amount of fixation dwell time (in msec) on the interest area to which the current fixation belongs.
CURRENT_FIX_INTEREST_ARE A_FIX_COUNT	Total number of fixations on the interest area to which the current fixation belongs.
CURRENT_FIX_INTERESTARE A_GROUP	Group label for the interest area to which the current fixation is assigned.
CURRENT_FIX_INTEREST AREA_INDEX	The index of the interest area in which the current fixation falls.
CURRENT_FIX_INTEREST_ARE A_LABEL	Label for the interest area to which the current fixation is assigned.
CURRENT_FIX_INTEREST_ARE A_RUN_ID	The ordinal sequence of the current run [2] of fixation(s) made towards the current interest area. If the current interest area does not have a previous run of fixation(s) on it, this variable will have a value of 1.
CURRENT_FIX_INTEREST_ARE A_X_OFFSET	Horizontal offset of the current fixation relative to the center of the interest area. If the fixation falls into multiple interest areas, returns the offset value relative to the first relevant interest area only. Returns a missing value (.) for freehand interest areas.
CURRENT_FIX_INTEREST_ARE A_Y_OFFSET	Vertical offset of the current fixation relative to the center of the interest area.
CURRENT_FIX_IS_RT_END	Whether the current fixation is the end event of RT definition
CURRENT_FIX_LABEL	Label of the current fixation.
CURRENT_FIX_MSG_COUNT	Number of visible messages associated with the current fixation event[1]. This number will not exceed the "Maximum Message Variables for Eye Event" set in the Output/Analysis Preference Settings.
CURRENT_FIX_MSG_TEXT_?	Text string for messages associated with the current fixation[1].
CURRENT_FIX_MSG_TIME_?	Trial time of the message[1].
CURRENT_FIX_NEAREST	Nearest interest area the current fixation is

_INTEREST_AREA	assigned to
CURRENT_FIX_NEAREST _INTEREST_AREA_DISTANCE	Distance between the current fixation point and the center of the nearest interest area the current fixation is associated with
CURRENT_FIX_NEAREST _INTEREST_AREA_LABEL	Label for the nearest interest area the current fixation is associated with
CURRENT_FIX_PUPIL	Pupil size of the current fixation
CURRENT_FIX_REFIX_INTEREST_AREA	Whether this trial has a previous fixation in a different run[2] that had the same interest area as the current fixation. If so, the CURRENT_FIX_INDEX value of the very first fixation in that interest area is given.
CURRENT_FIX_REFIX_PREV_INTEREST_AREA	Whether this trial has a previous fixation in an IA with higher IA ID than current fix IA ID (see run[2] definition).
CURRENT_FIX_RUN_DWELL_TIME	Total amount of dwell time (in msec) in the current run[2] of fixations.
CURRENT_FIX_RUN_INDEX	Ordinal sequence of the current fixation in the current run[2] of fixations. The first fixation in this run has a RUN_INDEX of 1 and the second one has RUN_INDEX value of 2, and so on.
CURRENT_FIX_RUN_SIZE	Number of fixations within the current run[2].
* CURRENT_FIX_START	Trial time when the current fixation starts
* CURRENT_FIX_START	Trial time when the current fixation starts (on the other eye in a binocular recording).
CURRENT_FIX_TRIAL_SPAN	Whether the fixation starts before the trial starts and ends after the trial starts, or starts before the trial ends and ends after the trial ends
CURRENT_FIX_X	X coordinate of the current fixation
CURRENT_FIX_X_OTHER	X coordinate of the current fixation (on the other eye in a binocular recording)
CURRENT_FIX_Y	Y coordinate of the current fixation
CURRENT_FIX_Y_OTHER	Y coordinate of the current fixation (on the other eye in a binocular recording).
	Note: Similar analyses are done for the previous fixation (variables beginning with PREVIOUS_FIX) and for the next fixation (variables beginning with NEXT_FIX).
DATA_FILE	File name of the recording;
EYE_USED	Which eye's data (LEFT or RIGHT) is used to create this report?
IP_END_TIME	End time (in milliseconds since EyeLink tracker

	was activated) of the interest period.
IP_LABEL	Label of the current interest period selected in the viewing session.
IP_START_TIME	Start time (in milliseconds since EyeLink tracker was activated) of the interest period.
LAST_BUTTON_PRESSED	ID of the pressed button
LAST_BUTTON_TIME	Trial time when the last button is pressed
NEXT_FIX_ANGLE, PREVIOUS_FIX_ANGLE	Angle between the horizontal plane and the line connecting the current fixation and the previous/next fixation (see 5-2)
NEXT_FIX_DIRECTION, PREVIOUS_FIX_DIRECTION	Direction (Left, Right, Top, Bottom), relative to the current fixation, in which the next/previous fixation is located
NEXT_FIX_DISTANCE, PREVIOUS_FIX_DISTANCE	Distance between the current fixation and the next/previous fixation in visual degrees
NEXT_SAC_AMPLITUDE	Amplitude of the following saccade in degrees of visual angle
NEXT_SAC_ANGLE	Angle between the horizontal plane and the direction of the next saccade (see 5-2)
NEXT_SAC_AVG_VELOCITY	Average velocity of the next saccade
NEXT_SAC_DIRECTION	Direction (Left, Right, Top, Bottom), relative to the current fixation, in which the next saccade is aiming
NEXT_SAC_DURATION	Duration of the next saccade in milliseconds
NEXT_SAC_END_INTEREST _AREAS	Interest area in which the end point of the next saccade falls
* NEXT_SAC_END_TIME	Trial time when the next saccade ends
NEXT_SAC_END_X, NEXT_SAC_END_Y	X, Y coordinates of the end point for the next saccade
NEXT_SAC_INDEX	Ordinal index of the next saccade
NEXT_SAC_IS_RT_END	Whether the next saccade is the end event of the RT definition
NEXT_SAC_LABEL	Label of the next saccade.
NEXT_SAC_MSG_COUNT	Number of visible messages associated with the next saccade event[1]. This number will not exceed the "Maximum Message Variables for Eye Event" set in the Output/Analysis Preference Settings.
NEXT_SAC_MSG_TEXT	Text string of the messages associated with the next saccade[1].
NEXT_SAC_MSG_TIME	Trial time1 of the message[1].
NEXT_SAC_NEAREST_END _INTEREST_AREA	Nearest interest area to which the end point of the next saccade is assigned

NEXT_SAC_NEAREST_END _INTEREST_AREA_LABEL	Label for the nearest interest area to which the end point of the next saccade is assigned
NEXT_SAC_NEAREST_START _INTEREST_AREA	Nearest interest area to which the start point of the next saccade is assigned
NEXT_SAC_NEAREST_START _INTEREST_AREA_LABEL	Label for the nearest interest area to which the start point of the next saccade is assigned
NEXT_SAC_PEAK_VELOCITY	Peak values of gaze velocity (in visual degrees per second) of the next saccade
NEXT_SAC_START_INTEREST _AREAS	Interest area in which the start point of the next saccade falls
* NEXT_SAC_START_TIME	Trial time when the next saccade ends
NEXT_SAC_START_X, NEXT_SAC_START_Y	X, Y coordinates of the start point for the next saccade
	Note: Similar analyses are done for the previous saccade (variables beginning with PREVIOUS_SAC)
TRIAL_FIXATION_TOTAL	Total number of fixations in a trial
TRIAL_LABEL	Label of the trial
* TRIAL_START_TIME	The start time (in milliseconds since EyeLink tracker was activated) of the trial.
VIDEO_FRAME_INDEX_START	Index of the video frame that was visible at the start of the eye event. Note that all "VIDEO_" variables are applicable to SceneLink recordings or some Experiment Builder recordings only. For SceneLink recordings, please check out the "Data Loading" Preference Settings.
VIDEO_FRAME_INDEX_END	Index of the video frame that was visible at the end of the eye event.
VIDEO_NAME_START	Name of the video frame that was visible at the start of the eye event.
VIDEO_NAME_END	Name of the video frame that was visible at the end of the eye event.

In addition to these default variables, other user-defined variables are also listed if they have been defined in the EDF file (see section 7.2.1 on creating trial variable labels) or created during the viewing session (see section 6.1.1 on trial variable manager).

Please note that the data output in the fixation report depends on the setting of interest period filter (see section 6.4.2 or Figure 6-13) – only those fixation and saccade events falling within the active interest period will be reported. If the "Trimmed Spanned Fixation Duration" setting of the "Data Filter" preference is enabled, the duration, start time, and end time of the fixations that overlap with the start or end of the interest period

will be adjusted accordingly. If a valid reaction time definition is found in a trial, the TRIAL_START_TIME will be set as the start as the reaction time definition; otherwise this will be set as the start of trial recording (see section 6.5.3 on discussion of three time periods used in Data Viewer). As a result, the values of CURRENT_FIX_END and CURRENT_FIX_START, which are calculated relative to TRIAL_START_TIME, will be different depending on whether a valid reaction time definition is found for the trial.

Note [1]: Messages written in the EDF file will be associated with an event closest in time. So, for a fixation report, the message could appear during a preceding saccade (PREVIOUS_SAC_MSG_*) or a following saccade (NEXT_SAC_MSG_*). In very rare cases, the message can be written to both saccade and fixation events if the message was written out after the last sample of a fixation (or saccade) but before the first sample of the following saccade (or fixation).

Note [2]: A run of fixations refers to a group of consecutive fixations that are directed towards the same interest area. Thus, for example, the interest areas of 10 fixations are: `A A B A A A C A E D.` The run count will be 7. The following table summarizes the values for some relevant variables.

Variables	A	A	B	A	A	A	C	A	E	D
Run (not listed in the variable list)	1	1	2	3	3	3	4	5	6	7
CURRENT_FIX_INDEX	1	2	3	4	5	6	7	8	9	10
CURRENT_FIX_INTEREST_AREA_INDEX	1	1	2	1	1	1	3	1	5	4
CURRENT_FIX_INTEREST_AREA_FIX_COUNT	6	6	1	6	6	6	1	6	1	1
CURRENT_FIX_INTEREST_AREA_RUN_ID	1	1	1	2	2	2	1	3	1	1
CURRENT_FIX_REFIX_INTEREST_AREA	0	0	0	1	1	1	0	1	0	0
CURRENT_FIX_REFIX_PREV_INTEREST_AREA	0	0	0	1	1	1	0	1	0	1
CURRENT_FIX_RUN_INDEX	1	2	1	1	2	3	1	1	1	1
CURRENT_FIX_RUN_SIZE	2	2	1	3	3	3	1	1	1	1

6.6.3 Configuring the Fixation Report

In addition to excluding some trials by entering a string in the "Exclude Trial String" edit box, the fixation report (similarly the saccade report and the interest area report) also allows the inclusion of hidden events in the relative event variables [PREVIOUS_ and

NEXT_]. This can be done by clicking the "Include Hidden Events in Relative Variables" check box. If the hidden events are included in the analysis, the user can further decide whether or not to treat these events as missing data.

6.7 Saccade Report

Saccade report creates a columnar output of saccade events in the data file. Each row of the report represents a saccade event. Depending on the variables selected for output, each row can contain information on the previous fixation and/or saccade, as well as the next fixation and/or saccade.

6.7.1 Obtaining a Saccade Report

To obtain a saccade report, adopt the same procedure as in obtaining the trial report, except from the menus, choose:

Analysis → Report → Saccade Report

6.7.2 Variables in the Saccade Report

Currently, the saccade report includes the following saccade-related information: index, start time, end time, start *xy* coordinates, end *xy* coordinates, duration, amplitude, angle, direction, average velocity, peak velocity, interest areas of the current, previous, and next saccades, and whether these saccades have been selected for analysis. It also contains the following information on the previous fixation and the next fixation: angle, blink around, direction, distance, duration, start time, end time, pupil size, trial span, the interest area in which the fixation is located, the nearest interest area, and whether the fixation has been selected for analysis. In addition, the report contains labels of the data file, data file, and individual trials, as well as other user-defined variables (see section 6.6.2 Variables in the Fixation Report for the complete list of variables and their meanings).

6.8 Interest Area Report

Interest area report provides a columnar output of eye movement data for each interest area in a trial. Each row of the report represents an interest area, arranged in an ascending order of the interest area ID.

6.8.1 Obtaining an Interest Area Report

To obtain an interest area report, adopt the same procedure as in obtaining the trial report, except from the menus, choose:

Analysis → Report → Interest Area Report

6.8.2 Variables in the Interest Area Report

Currently, the interest area report provides information for the following variables:

Field	Contents
RECORDING_SESSION_LABEL	Label of the data file
DATA_FILE	File name of the recording
EYE_USED	Which eye's data (LEFT or RIGHT) is used to create this report?
IA_AREA	Pixel area for the current interest area
IA_AVERAGE_FIX_PUPIL_SIZE	Average pupil size across all fixations in the interest area.
IA_BOTTOM	Bottom side pixel position of non-freehand IA.
IA_DWELL_TIME	Dwell time (i.e., summation of the duration across all fixations) on the current interest area
IA_DWELL_TIME_%	Percentage of trial time spent on the current interest area
IA_FIRST_FIXATION_DURATION	Duration of the first fixation event that was within the current interest area.
* IA_FIRST_FIXATION_TIME	Start time of the first fixation to enter the current interest area.
IA_FIRST_FIX_PROGRESSIVE	Checks whether later interest areas have been visited before the first fixation enters the current interest area. 1 if NO higher IA ID in earlier fixations before the first fixation in the current interest area; 0 otherwise.
IA_FIRST_RUN_DWELL_TIME	Dwell time (i.e., summation of the duration across all fixations) of the first run within the current interest area.
* IA_FIRST_RUN_END_TIME	End time of the first run of fixations in the current interest area.
IA_FIRST_RUN_FIXATION_%	Percentage of all fixations in a trial falling in the first run of the current interest area.
IA_FIRST_RUN_FIXATION_COUNT	Number of all fixations in a trial falling in the first run of the current interest area.
* IA_FIRST_RUN_START_TIME	Start time of the first run of fixations in the current interest area.
*IA_FIRST_SACCADE_END_TIME	End time of the saccade that first landed within the current interest area.
*IA_FIRST_SACCADE_START_TIME	Start time of the saccade that first landed within the current interest area.
IA_FIXATION_%	Percentage of all fixations in a trial falling in the current interest area

IA_FIXATION_COUNT	Total fixations falling in the interest area
IA_FSA_COUNT	The number of fixations (fixation N) which started in the current row of interest area, with fixation N + fixation_skip_count ending in the current column of interest area.
IA_FSA_DURATION	The summed duration for all fixations (fixation N) which started in the current row of interest area, with fixation N + fixation_skip_count ending in the current column of interest area.
IA_GROUP	Group label for the current interest area.
IA_ID	Ordinal ID of the current interest area
IA_LABEL	Label for the current interest area
IA_LAST_FIXATION_DURATIO N	Duration of the last fixation event that was within the current interest area.
* IA_LAST_FIXATION_TIME	Start time of the last fixation to enter the current interest area.
*IA_LAST_SACCADE_END_TI ME	End time of the saccade that last landed within the current interest area.
*IA_LAST_SACCADE_START_T IME	Start time of the saccade that last landed within the current interest area.
IA_LEFT	Left side pixel position of non-freehand IA.
IA_LEGAL	A trial is considered legal (i.e., IA_LEGAL = 1) only if the first fixation in 'interest area N' was preceded by a fixation in interest area (N-1). This variable is relevant for experiments that run in a contingent display paradigm, as it ensures that readers could see the target area before actually lending in it.
IA_MAX_FIX_PUPIL_SIZE	Maximum pupil size among all fixations in the interest area. Note this measure does not represent the maximum pupil size within a fixation.
IA_MIN_FIX_PUPIL_SIZE	Minimum pupil size among all fixations in the interest area. Note this measure does not represent the minimum pupil size within a fixation.
IA_POINTS	List of x,y points for freehand Interest Areas.
IA_REGRESSION_IN	Whether the current interest area received at least one regression from later interest areas (e.g., later parts of the sentence). 1 if interest area was entered from a higher IA_ID (from the right in English); 0 if not.
IA_REGRESSION_IN_COUNT	Number of times interest area was entered from a higher IA_ID (from the right in English).

IA_REGRESSION_OUT	Whether regression(s) was made from the current interest area to earlier interest areas (e.g., previous parts of the sentence) prior to leaving that interest area in a forward direction. 1 if a saccade exits the current interest area to a lower IA_ID (to the left in English) before a later interest area was fixated; 0 if not.
IA_REGRESSION_OUT_FULL	Whether regression(s) was made from the current interest area to earlier interest areas (e.g., previous parts of the sentence). 1 if a saccade exits the current interest area to a lower IA_ID (to the left in English); 0 if not. Note that IA_REGRESSION_OUT only considers first-pass regressions whereas IA_REGRESSION_OUT_FULL considers all regressions, regardless whether later interest areas have been visited or not.
IA_REGRESSION_OUT_FULL_COUNT	Number of times interest area was exited to a lower IA_ID (to the left in English).
IA_REGRESSION_OUT_COUNT	Number of times interest area was exited to a lower IA_ID (to the left in English) before a higher IA_ID was fixated in the trial.
IA_REGRESSION_PATH_DURATION	The summed fixation duration from when the current interest area is first fixated until the eyes enter an interest area with a higher IA_ID.
IA_RIGHT	Right side pixel position of non-freehand IA.
IA_REGRESSION_PATH_DURATION	The summed fixation duration from when the current interest area is first fixated until the eyes enter an interest area with a higher IA_ID.
IA_RUN_COUNT	Number of times the Interest Area was entered and left (runs)
IA_SECOND_FIXATION_DURATION	Duration of the second fixation in IA, regardless of run.
IA_SECOND_FIXATION_RUN	Index of run that the second fixation is in.
* IA_SECOND_FIXATION_TIME	Time of the second fixation in IA, regardless of run.
IA_SECOND_RUN_DWELL_TIME	Dwell time (i.e., summation of the duration across all fixations) of the second run of fixations within the current interest area.
* IA_SECOND_RUN_END_TIME	End time of the second run of fixations in the current interest area.
IA_SECOND_RUN_FIXATION_	Percentage of all fixations in a trial falling in the

%	second run of the current interest area.
IA_SECOND_RUN_FIXATION_COUNT	Number of all fixations in a trial falling in the second run in the current interest area.
*IA_SECOND_RUN_START_TIME	Start time of the second run of fixations in the current interest area.
IA_SELECTIVE_REGRESSION_PATH_DURATION	Duration of fixations and refixations of the current interest area before the eyes enter an interest area with a higher ID.
IA_SKIP	An interest area is considered skipped (i.e., IA_SKIP = 1) if no fixation occurred in first-pass reading.
IA_SPILLOVER	The duration of the first fixation made on 'interest area (N+1)' after leaving 'interest area N' in first pass.
IA_THIRD_FIXATION_DURATION	Duration of the third fixation in IA, regardless of run.
IA_THIRD_FIXATION_RUN	Index of run that the third fixation is in.
*IA_THIRD_FIXATION_TIME	Time of the third fixation in IA, regardless of run.
IA_THIRD_RUN_DWELL_TIME	Dwell time (i.e., summation of the duration across all fixations) of the third run of fixations within the current interest area.
*IA_THIRD_RUN_END_TIME	End time of the third run of fixations in the current interest area.
IA_THIRD_RUN_FIXATION_%	Percentage of all fixations in a trial falling in the third run of the current interest area.
*IA_THIRD_RUN_START_TIME	Start time of the third run of fixations in the current interest area.
IA_TYPE	Type of interest area (rectangular, elliptic, or freehand)
IA_TOP	Top side pixel position of non-freehand IA
IP_END_TIME	End time (in milliseconds since EyeLink tracker was activated) of the interest period.
IP_LABEL	Label of the current interest period selected in the viewing session.
IP_START_TIME	Start time (in milliseconds since EyeLink tracker was activated) of the interest period.
TRIAL_DWELL_TIME	Dwell time (i.e., summation of all fixation durations) for the whole trial
TRIAL_FIXATION_COUNT	Total number of fixations in the trial
TRIAL_LABEL	Label of the trial

* TRIAL_START_TIME	The start time (in milliseconds since EyeLink tracker was activated) of the trial.

In addition, other user-defined trial variable labels will also be listed. Note: since version 1.3 of Data Viewer, all eye event start and end times in the interest area report are made relative to trial start instead. The absolute time of eye events can be obtained by adding "TRIAL_START_TIME".

6.8.3 Using Interest Area Report

The data output in the interest area report depends on the setting of the interest period filter (see section 6.4.2 or Figure 6-13) – only those fixation and saccade events falling within the active interest period will be reported. If a valid reaction time definition is found in a trial, the TRIAL_START_TIME will be set as the start as the reaction time definition; otherwise this will be set as the start of trial recording (see section 6.5.3 on discussion of three time periods used in Data Viewer). As a result, the values of all of variables marked with a "*" symbol, which are calculated relative to TRIAL_START_TIME, will be different depending on whether a valid reaction time is found in the trial. If the "Trimmed Spanned Fixation Duration" setting of the "Data Filter" preference is enabled, the duration, start time, and end time of the fixations that overlap with the start or end of the interest period will be adjusted accordingly.

Some variables in the interest area report may be influenced by the outlier fixations that do not belong to any interest area. For example, the presence of an outlier fixation may break the run of fixations on a particular interest area and therefore shortens the measure of IA_FIRST_RUN_DWELL_TIME and increases the IA_RUN_COUNT value. Therefore, users should ensure that all fixations are assigned to a particular interest area before creating an interest area report, if "run"-related measures are important. Users can either manually move the position of those outlier fixations or, more conveniently, enable the "Use Nearest Interest Area for Outlier Fixations" option of the Output/Analysis preference settings.

Interest area report was designed to support analysis of data from different research paradigms and, therefore, the user only needs to use a small portion of variables in one output. **If you have lots of interest areas in a trial, including IA_FSA_COUNT and IA_FSA_DURATION in the output report may take a very long time for the Viewer to generate the report.** A progress dialog (see Figure 6-14) will be displayed while creating the report. The user may abort the process by pressing the "Cancel" button.

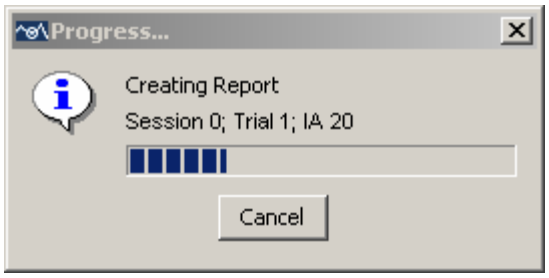
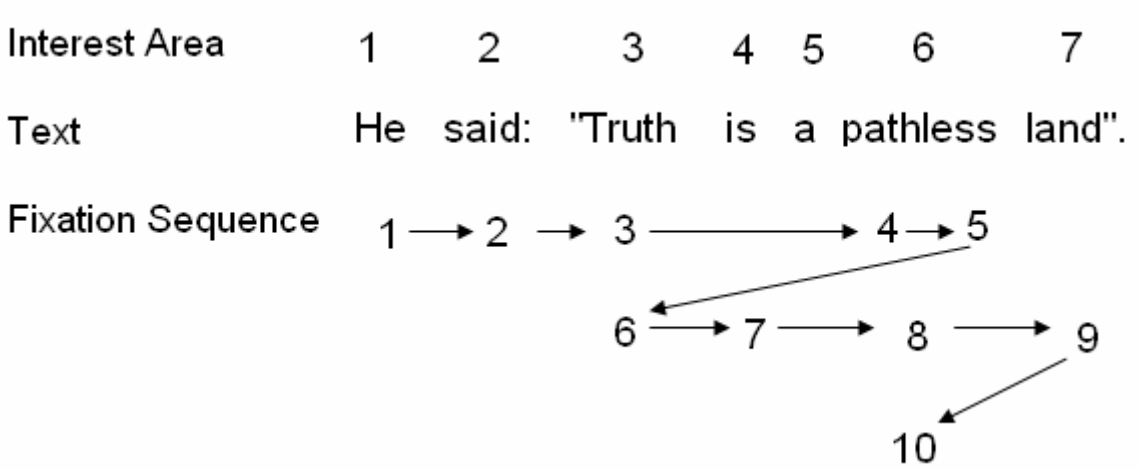


Figure 6-14. Progress Dialog Box Displayed when Creating the Interest Area Report

6.8.3.1 Fixation Sequence Analysis

Variables IA_FSA_COUNT and IA_FSA_DURATION are used primarily for fixation sequence analysis (i. e., examination of the frequency of saccades directed from the current interest area to all interest areas). If there are N interest areas in a trial, this will generate N columns in the output report, with column labels being IA_FSA_COUNT_1 to IA_FSA_COUNT_N for counts and IA_FSA_DURATION_1 to IA_FSA_DURATION_N for duration outputs. Each column in the output file reports number of fixations coming to one particular interest area from each of all possible interest areas. Each row reports number of fixations starting from the current interest area and ending at each of the interest areas (when "Fixation Skip Count" in the Output/Analysis preference settings is set to 1).



IA_ID		IA_FSA_COUNT_1	IA_FSA_COUNT_2	IA_FSA_COUNT_3	IA_FSA_COUNT_4	IA_FSA_COUNT_5	IA_FSA_COUNT_6	IA_FSA_COUNT_7
	IA_LABEL	He	said:	"Truth	is	a	pathless	Land".
1	He	0	1	0	0	0	0	0
2	said:	0	0	1	0	0	0	0
3	'Truth	0	0	0	1	0	1	0
4	is	0	0	0	0	0	1	0
5	a	0	0	0	0	0	0	0
6	pathless	0	0	1	0	0	1	1
7	land?.	0	0	0	0	0	1	0

The above example illustrates the use of fixation sequence analysis. Take interest area #6 ("pathless") for example. It received four fixations in total. These fixations came from interest area #3 (Fixation 4), #6 (Fixation 5), #4 (Fixation 8), and #7 (Fixation 10). This is reported in the column "IA_FSA_COUNT_6". There are three fixations starting from interest area #6: Fixation 5 (to IA #6), Fixation 6 (to IA #3), and Fixation 9 (to IA #7). This is reported in the row with IA_ID being 6 ("pathless").

Please note that the user should also check the setting for "Fixation Skip Count" in the Output/Analysis preference settings. The fixation skip count defines the number (should be an integer no less than 1) of fixations to skip when looking for the next interest area to use in the fixation sequence analysis variables of the Interest Area report. The default setting is 1 and uses the next available fixation for the sequence analysis (from the current interest area to all interest area). A value of 2 uses the fixation following the next one for the analysis, and so on.

6.8.3.2 Regression Analysis

A lot of the variables in the interest area report are intended for the regression analysis, especially in the reading research. The following example illustrates the use the interest area report in the regression analysis.

IA_ID	1	2	3	4	5	6	7
IA_LABEL	He	said:	"Truth	is	a	pathless	Land".
IA_DWELL_TIME	F1	F2	F3 + F6	F7	0	F4 + F5 + F8 + F10	F9
IA_FIXATION_COUNT	1	1	2	1	0	4	1
IA_RUN_COUNT	1	1	2	1	.	3	1
IA_FIRST_FIX_PROGRESSIVE	1	1	1	0	.	1	1
IA_FIRST_FIXATION_DURATION	F1	F2	F3	F7	.	F4	F9
IA_FIRST_RUN_DWELL_TIME	F1	F2	F3	F7	.	F4 + F5	F9
IA_SECOND_FIXATION_DURATION	.	.	F6	.	.	F5	.
IA_SECOND_FIXATION_RUN	.	.	2	.	.	1	.
IA_SECOND_RUN_DWELL_TIME	.	.	F6	.	.	F8	.
IA_REGRESSION_IN	0	0	1	0	.	1	0
IA_REGRESSION_IN_COUNT	0	0	1	0	.	1	0
IA_REGRESSION_OUT	0	0	0	0	.	1	0
IA_REGRESSION_OUT_COUNT	0	0	0	0	.	1	0

IA_REGRESSION_PATH_DURATION	F1	F2	F3	F7		F4 + F5 + F6 + F7 + F8	F9
IA_SELECTIVE_REGRESSION_PATH_DURATION	F1	F2	F3	F7	.	F4 + F5 + F8	F9

Take interest area #6 (“pathless”) for example. IA_REGRESSION_PATH_DURATION includes the first pass fixations on the interest area (F4 + F5), time spent in previous parts of the sentence following regressive eye movements (F6 + F7), and time due to refixations coming from the left before the eyes move past the interest area (F8). The calculation of IA_SELECTIVE_REGRESSION_PATH_DURATION only includes the first run fixation on the interest area (F4+F5) and the refixations on the interest area (F8) before the eyes enter next interest area with a higher IA_ID (“land”).

IA_FIRST_FIX_PROGRESSIVE checks whether later interest areas have been visited before the first fixation enters the current interest area. Therefore, this variable would be 0 for the interest area “is” because it was fixated on Fixation 7 while Fixations 4 and 5 were on later part of the sentence (“pathless”). IA_REGRESSION_OUT checks whether at least one regression was made from the current interest area to previous parts of the sentence prior to leaving that interest area in a forward direction. Therefore, the transition from F5 → F6 makes this flag true for the interest area #6 (labeled as “pathless”). IA_REGRESSION_IN checks whether a given interest area received at least one regression from later parts of the sentence. Therefore, this is true for both interest areas #3 “truth” (F5 → F6) and #6 “pathless” (F9 → F10).

6.9 Sample Output Report

Sample output report provides a columnar output of eye movement data for each eye sample in a trial. The sample report option will not be available if the samples are not loaded into a viewing session. As in the other reports, sample output report only outputs samples that fall within the active interest period for the trial.

6.9.1 Loading Samples into a Viewing Session

Version 1.7 of Data Viewer introduced a change to optimize the viewer performance by not loading the samples by default (see revision history). To make sample data available to a viewing session, you will need to first change the data loading preferences and then reload the EDf file.

1) Before loading any EDF files, please go to "Start -> Programs -> SR Research -> EyeLink -> Data Viewer" to start the software.
2) Once the application starts up, click "Preferences" tab and go to "Data Loading" preferences. Check the "Load Samples" option. If you want this changes to be persistent over future viewing sessions, you may consider saving this as default setting. This can be done by selecting the topmost preference tree node, clicking the right mouse buttons and selecting "Save Properties as Defaults".

3) Once you have done step 2), this will make the properties persist over future data viewing sessions. Now, start loading in the EDF files.

6.9.2 Obtaining a Sample Output Report

To obtain a sample report, adopt the same procedure as in obtaining the trial report, except from the menus, choose:

Analysis → Report → Sample Report

6.9.3 Variables in the Sample Output Report

Currently, the sample output report provides output for the following variables:

Field	Contents
RECORDING_SESSION_LABEL	Label of the data file
AVERAGE_ACCELLERATION_X	Acceleration value (in degree/second/second) along the x axis across two eyes[1].
AVERAGE_ACCELLERATION_Y	Acceleration value (in degree/second/second) along the y axis across two eyes[1].
AVERAGE_GAZE_X	Gaze coordinate along the x axis across two eyes[1].
AVERAGE_GAZE_Y	Gaze coordinate along the y axis across two eyes[1].
AVERAGE_INTEREST_AREA_ID	Index of the interest area in which the current sample (average across two eyes [1]) falls.
AVERAGE_INTEREST_AREA_LABEL	Label of the interest area in which the current sample (average across two eyes [1]) falls.
AVERAGE_PUPIL_SIZE	Pupil size of the current sample across two eyes.
AVERAGE_VELOCITY_X	Velocity value (in degree/second) along the x axis across two eyes[1].
AVERAGE_VELOCITY_Y	Velocity value (in degree/second) along the y axis across two eyes[1].
DATA_FILE	File name of the recording;
HTARGET_DISTANCE	Distance between the head target and eye camera (in millimeters) for an EyeLink Remote recording. Returns a missing value if the head target was missing or if the data was recorded with a non-Remote eye tracker.
HTARGET_X	X position of the head target in camera coordinate for an EyeLink Remote recording. Returns a missing value if the head target was missing or if the data was recorded with non-

	Remote eye tracker.
HTARGET_Y	Y position of the head target in camera coordinate for an EyeLink Remote recording. Returns a missing value if the head target was missing or if the data was recorded with non-Remote eye tracker.
HTARGET_FLAGS	Flags used to indicate the head target tracking status ('.....' if target tracking is ok; otherwise error code) for an EyeLink Remote recording. Returns a missing value if the data was recorded with non-Remote eye tracker.
IP_DURATION	Duration of the interest period in milliseconds.
IP_END_TIME	End time (in milliseconds since EyeLink tracker was activated) of the interest period.
IP_LABEL	Label of the current interest period selected in the viewing session.
IP_START_TIME	Start time (in milliseconds since EyeLink tracker was activated) of the interest period. TRIAL_LABEL Label of the trial
LEFT_ACCELLERATION_X	Acceleration value (in degree/second/second) of the left eye along the x axis.
LE FT_ACCELLERATION_Y	Acceleration value (in degree/second/second) of the left eye along the y axis.
LEFT_GAZE_X	Left eye gaze coordinate along the x axis.
LEFT_GAZE_Y	Left eye gaze coordinate along the y axis.
LEFT_INTEREST_AREA_ID	Index of the interest area in which the left-eye sample falls.
LEFT_INTEREST_AREA_LABEL	Label of the interest area in which the left-eye sample falls.
LEFT_IN_BLINK	Whether the left eye is in a blink.
LEFT_IN_SACCADE	Whether the left eye is in a saccade.
LEFT_PUPIL_SIZE	Left eye pupil size of the current sample.
LEFT_VELOCITY_X	Velocity value (in degree/second) of the left eye along the x axis.
LEFT_VELOCITY_Y	Velocity value (in degree/second) of the left eye along the y axis.
RESOLUTION_X	Horizontal angular resolution (in screen pixels per degree) for the sample.
RESOLUTION_Y	Vertical angular resolution (in screen pixels per degree) for the sample.
RIGHT_ACCELLERATION_X	Acceleration value (in degree/second/second) of the right eye along the x axis.

RIGHT_ACCELLERATION_Y	Acceleration value (in degree/second/second) of the right eye along the y axis.
RIGHT_GAZE_X	Right eye gaze coordinate along the x axis.
RIGHT_GAZE_Y	Right eye gaze coordinate along the y axis.
RIGHT_INTEREST_AREA_ID	Index of the interest area in which the right-eye sample falls.
RIGHT_INTEREST_AREA_LABEL	Label of the interest area in which the right-eye sample falls.
RIGHT_IN_BLINK	Whether the right eye is in a blink.
RIGHT_IN_SACCADE	Whether the right eye is in a saccade.
RIGHT_PUPIL_SIZE	Right eye pupil size of the current sample.
RIGHT_VELOCITY_X	Velocity value (in degree/second) of the right eye along the x axis.
RIGHT_VELOCITY_Y	Velocity value (in degree/second) of the right eye along the y axis.
SAMPLE_BUTTON	If the EyeLink button box is pressed, this records the ID of the EyeLink button number.
SAMPLE_INDEX	The index of the sample in the trial.
SAMPLE_MESSAGE	Message text printed out during the current sample.
TARGET_ACCELLERATION_X	Acceleration value (in degree/second/second) of the target along the x axis.
TARGET_ACCELLERATION_Y	Acceleration value (in degree/second/second) of the target along the y axis.
TARGET_VELOCITY_X	Velocity value (in degree/second) of the target along the x axis.
TARGET_VELOCITY_Y	Velocity value (in degree/second) of the target along the y axis.
TARGET_VISIBLE	Whether the target is visible during the current sample. To support the retrieval of target position from a sample report, the target position data must be written according to some format (see section "Protocol for EyeLink Data to Viewer Integration -> Target Position Commands").
TARGET_X	Target gaze position on x axis.
TARGET_Y	Target gaze position on y axis.
TIMESTAMP	The time stamp of the sample (in milliseconds since EyeLink tracker was activated).
TRIAL_LABEL	Label of the trial
* TRIAL_START_TIME	The start time (in milliseconds since EyeLink tracker was activated) of the trial.

VIDEO_FRAME_INDEX	Index of the video frame that was visible at the sample time. Note that all "VIDEO_" variables are applicable to SceneLink recordings or some Experiment Builder recordings only. For SceneLink recordings, please check out the "Data Loading" Preference Settings.
VIDEO_NAME	Name of the video frame that was visible at the sample time.

Note [1]: All "AVERAGE_*" measures will have a missing value if both eye samples are not available (if pupils are missing or recording is done with left-eye or right-eye only).

In addition, other user-defined trial variable labels will also be listed. Please note that the data output in the sample report depends on the setting of the interest period filter (see section 6.4.2 or Figure 6-13) – only those fixation and saccade events falling within the active interest period will be reported. If a valid reaction time definition is found in a trial, the TRIAL_START_TIME will be set as the start as the reaction time definition; otherwise this will be set as the start of trial recording (see section 6.5.3 on discussion of three time periods used in Data Viewer).

6.10 Message Output Report

Message output report provides a columnar output of messages written in each trial as well as the eye movement events to which the message is associated. As with the other reports, message report only outputs messages that fall within the active interest period for the trial.

6.10.1 Obtaining a Message Output Report

To obtain an output report for messages, from the application menus, choose:

Analysis → Report → Message Report

6.10.2 Variables in the Message Output Report

Currently, the following variables are included in the message output report:

Field	Contents
RECORDING_SESSION_LABEL	Label of the data file
CURRENT_MSG_BLINK_DURATION	Duration of the blink to which the message is associated.
CURRENT_MSG_BLINK_END	End time (relative to the start of the interest period) of the blink to which the message is

	associated.
CURRENT_MSG_BLINK_INDEX	Index of the blink to which the message is associated.
CURRENT_MSG_BLINK_START	Start time (relative to the start of the interest period) of the blink during which the message was written.
CURRENT_MSG_FIX_DURATION	Duration of the fixation to which the message is associated.
CURRENT_MSG_FIX_END	End time (relative to the start of the interest period) of the fixation to which the message is associated.
CURRENT_MSG_FIX_INDEX	Index of the fixation to which the message is associated.
CURRENT_MSG_FIX_START	Start time (relative to the start of the interest period) of the fixation to which the message is associated.
CURRENT_MSG_FIX_X	X position of the fixation to which the message is associated.
CURRENT_MSG_FIX_Y	Y position of the fixation to which the message is associated.
CURRENT_MSG_INDEX	Index of the current message.
CURRENT_MSG_IS_RT_END	Whether the current message is the end event of a reaction-time definition.
CURRENT_MSG_IS_RT_START	Whether the current message is the start event of a reaction-time definition.
CURRENT_MSG_LABEL	Label of the current message event.
CURRENT_MSG_SAC_AMPLITUDE	Amplitude (in degrees of visual angle) of the saccade to which the message is associated.
CURRENT_MSG_SAC_AVG_VELOCITY	Average velocity (in degrees/second) of the saccade to which the message is associated.
CURRENT_MSG_SAC_DURATION	Duration of the saccade to which the message is associated.
CURRENT_MSG_SAC_END_TIME	End time (relative to the start of the interest period) of the saccade to which the message is associated.
CURRENT_MSG_SAC_END_X	X coordinate of the end point for the saccade to which the message is associated.
CURRENT_MSG_SAC_END_Y	Y coordinate of the end point for the saccade to which the message is associated.
CURRENT_MSG_SAC_INDEX	Index of the saccade to which the message is associated.

CURRENT_MSG_SAC_PEAK_VELOCITY	Peak velocity (in degrees/second) of the saccade to which the message is associated.
CURRENT_MSG_SAC_START_TIME	Start time (relative to the start of the interest period) of the saccade to which the message is associated.
CURRENT_MSG_SAC_START_X	X coordinate of the start point for the saccade to which the message is associated.
CURRENT_MSG_SAC_START_Y	Y coordinate of the start point for the saccade to which the message is associated.
CURRENT_MSG_TEXT	Text string of the current message.
CURRENT_MSG_TIME	Trial time (relative to the start of the interest period) of the message.
CURRENT_MSG_X_POSITION	X position of the current message text. It may be a missing value if samples are not loaded in the viewing session.
CURRENT_MSG_Y_POSITION	Y position of the current message text. It may be a missing value if samples are not loaded in the viewing session.
DATA_FILE	File name of the recording;
EYE_USED	Which eye's data (LEFT or RIGHT) is used to create this report?
IP_DURATION	Duration of the interest period in milliseconds.
IP_END_TIME	End time (in milliseconds since EyeLink tracker was activated) of the interest period.
IP_LABEL	Label of the current interest period selected in the viewing session.
IP_START_TIME	Start time (in milliseconds since EyeLink tracker was activated) of the interest period. TRIAL_LABEL Label of the trial
* TRIAL_START_TIME	The start time (in milliseconds since EyeLink tracker was activated) of the trial.

Note: Messages written in the EDF file will be associated with an event closest in time. In very rare cases, the message can be written to both saccade and fixation events if the message was written out after the last sample of a fixation (or saccade) but before the first sample of the following saccade (or fixation).

In addition, other user-defined trial variable labels will also be listed. Please note that the data output in the message report depends on the setting of the interest period filter (see section 6.4.2 or Figure 6-13) – only those events falling within the active interest period will be reported. If a valid reaction time definition is found in a trial, the

TRIAL_START_TIME will be set as the start as the reaction time definition; otherwise this will be set as the start of trial recording (see section 6.5.3 on discussion of three time periods used in Data Viewer).

6.11 Recording Event Sequence Data

Recording Event Sequence Data is a trimmed version of the EyeLink ASC file. For each trial, it outputs the selected events only and excludes the hidden events.

6.11.1 Obtaining a Recording Event Sequence Data

To obtain a recording event sequence data report:

1) From the menus, choose:
   Analysis → Report → Recording Event Sequence Data.
2) In the Export dialog box, browse to the directory in which you want to save the data.
3) In the File name text box, type in the name for the data.
4) Press Export button.

6.11.2 Formats of the Recording Event Sequence Data

The following output is a trimmed version of a sample recording event sequence report.

```
MSG    5520005 DISPLAY_COORDS 0 0 1023 767
MSG    5520005 FRAMERATE 85.05 Hz.
MSG    5520009 TRIAL_VAR_LABELS PAGE
MSG    5684435 TRIALID PAGE1
START 5686598
BUTTON 5686573 5 true
MSG    5686595 DRIFTCORRECT R RIGHT at 320,40  OFFSET 0.09 deg.  4.1,1.4 pix.
MSG    5686597 RECCFG P 500 2 1
MSG    5686597 GAZE_COORDS 0.00 0.00 1023.00 767.00
EFIX   R 5686602 5686852 252 514.2 388.9 49.0   50.95  45.0   false  [72: dogs, ]
BUTTON 5686716 5 false
MSG    5686723 DISPLAY ON
MSG    5686726 SYNCTIME 3
ESACC  R 5686854 5686900 48 514.1 385.7  342.1  84.5   7.58   229.0  50.55  44.45
EFIX   R 5686902 5686980 80 340.2 80.6   47.0   50.2   43.9   false  [5: the ]
ESACC  R 5686982 5687012 32 339.6 84.4   192.6  46.9   3.05   162.0  50.25  43.85
EFIX   R 5687014 5687176 164 195.0 44.4  46.0   50.3   43.8   false  [3: not ]
ESACC  R 5687178 5687192 16 189.7 41.5   155.1  38.1   0.69   62.0   50.35  43.8
EFIX   R 5687194 5687364 172 153.8 45.2  44.0   50.4   43.8   false  [2: did ]
```

```
ESACC  R 5687366 5687384 20 157.9 47.8   232.8  51.9   1.49   116.0  50.3   43.8
EFIX   R 5687386 5687588 204 233.9 54.8  45.0   50.25  43.8   false  [3: not ]
ESACC  R 5718822 5718836 16 621.3 723.4  677.1  712.5  1.09   96.0   52.35  46.7
EFIX   R 5718838 5718968 132 684.3 710.4  46.0  52.45  46.7   false  [142: sides.]
ESACC  R 5718970 5719032 64 685.0 706.9  347.0  106.4  14.87  371.0  51.3   45.05
EFIX   R 5719034 5719336 304 356.5 131.3 43.0   50.25  43.5   false  [16: not ]
BUTTON 5719243 5 true
MSG    5719244 ENDBUTTON 5
END 5719345
MSG    5719360 TRIAL OK
```

In this output file, the display coordinates and frame rate were reported first, followed by information from individual trials. This includes the selected fixations, saccades, blinks, messages, and button events and excludes any hidden events. For a Data Viewing session that loads in several recording sessions, only the first recording session will be exported in the recording event sequence output file.

6.11.2.1 Fixation Events

Fixation events are recorded in the format of:

- EFIX <eye> <stime> <etime> <dur> <axp> <ayp> <aps> <xr> <yr> <ma> <ia>

This reports the eye used in the recording, the time of the first and last sample in the fixation, and computes the duration of the fixation in milliseconds. The average X and Y eye position (the type of position data is determined when the event was generated) and the average pupil size (area or diameter) are reported. The horizontal and vertical eye-position angular resolutions (in pixels per visual degree) are reported next. In addition, the output contains information on whether the fixation has been manually adjusted <ma> and the ID and name of the interest area in which the current fixation falls <ia>.

6.11.2.2 Saccade Events

Saccade events are recorded in the format of:

- ESACC <eye> <stime> <etime> <dur> <sxp> <syp> <exp> <eyp> <ampl> <pv> <xr> <yr>

This reports the time of the first and last sample in the saccade, and computes its duration in milliseconds. The X and Y eye position at the start and end of the saccade (<sxp>, <syp>, <exp>, <eyp>) are listed. The total visual angle covered in the saccade is reported by <ampl>, which can be divided by (<dur>/1000) to obtain the average velocity. Peak velocity is given by <pv>. The horizontal and vertical eye-position angular resolutions (in pixels per visual degree) are given as well.

6.11.2.3 Blink Events

Blink events are recorded in the format of:

- EBLINK <eye> <stime> <etime> <dur>

This reports the eye used in the recording, the time of the first and last sample in the blink, and computes the duration of the blink in milliseconds.

6.11.2.4 Message Events

Messages are recorded in the format of:

- MSG <time> <message>

A message line contains the text of a time stamped message. The <message> text fills the entire line after the timestamp <time> and any blank space following it.

6.11.2.5 Button Events

Button events are recorded in the format of:

- BUTTON <time > <button #> <button_pressed>

Button lines report a change in state of tracker buttons. The <button #> reports which button has changed state. The <button_pressed> value will be true if the button has been pressed, false if it has been released.

7 Protocol for EyeLink Data to Viewer Integration

The EyeLink Data Viewer can interpret a set of message commands from an EyeLink data file that allow the viewer to automate some of the viewer configuration for a given data file or trial. Examples of these commands include defining the image to overlay and specifying trial variables. These messages can be written by the display experiment to the EDF file using the API function that allows the writing of a custom message to the EDF file.

Messages that make up the EyeLink data file protocol for the viewer are not added to the Message list that is created for viewing within the viewer tool. Message commands are therefore invisible to the viewing windows, and are only interpreted by the Viewer during application loading.

Important: Do not use space characters in any component of a viewer message command; the space character is used to tokenize and interpret all viewer messages. Instead of using a space character within a message token, use the _ character.

7.1 Defining the Start and End of a Trial

The viewer uses two special message commands to define what should be considered the start and end of a trial for the purpose of parsing the EyeLink data files.

7.1.1 Trial Start Message

Identifier (Default): TRIALID

Description:

This message defines the start of a trial for the viewer. This is different than the start of recording message START that is logged when the trial recording begins. The viewer will not parse any messages, events, or samples, that exist in the data file prior to this message. The command identifier can be changed in the data loading preference settings.

Format:

```
TRIALID  <Trial ID value list>
```

Example:

```
MSG   3362269 TRIALID PIX1 images\sacrmeto.jpg
```

Note: If the trial start message is not found, or if no trial start message is defined for the viewing session, the START message is used to indicate the start of a trial for the Viewer.

7.1.2 Trial End Message

Identifier (Default): TRIAL_RESULT

Description:

This message defines the end of a trial for the viewer. This is different than the end of recording message END that is logged when the trial recording ends. The viewer will not parse any messages, events, or samples that exist in the data file after this message. The command identifier can be changed in the data loading preference settings.

Format:

```
TRIAL_RESULT  <possible trial result values>
```

Example:

```
MSG 3383842 TRIAL_RESULT 0
```

Note: If the trial end message is not found, or if no trial end message is defined for the viewing session, the END message is used to indicate the end of a trial for the Viewer.

7.2 Pre-Trial Message Commands

The following message commands, if defined, MUST be sent to the EyeLink data file prior to the Trial Start message defined above (i.e., outside the scope of a trial as defined for the viewer). If they are sent during trial recording, these messages will not be interpreted.

7.2.1 Trial Variable Labels

Identifier (Default): TRIAL_VAR_LABELS

Description:

This message allows the definition of the labels to be used for trial variables within the viewer. The command identifier can be changed in the data loading preference settings.

Format:

```
TRIAL_VAR_LABELS  <trial variable list>
```

Example:

```
MSG   3363553 TRIAL_VAR_LABELS TRIAL_VAR_1 TRIAL_VAR_2 TRIAL_VAR_3
```

7.2.2 Display Coordinates

Identifier: DISPLAY_COORDS or GAZE_COORDS

Description:

This message specifies the display coordinates to be used within the viewer. This message MUST be present for the viewer to function correctly.

Format:
`DISPLAY_COORDS  <left>  <top>  <right>  <bottom>`
Left, top, right, and bottom refer to the x-y coordinates of the top-left and bottom-right corners of display.

Example:

```
MSG   3325521 DISPLAY_COORDS 0 0 1279 1023
```

7.2.3 Trial Grouping

Identifier: V_TRIAL_GROUPING
Description:

Trial grouping message is used to group those trials in the same experimental condition together so that they can be manipulated (e.g., selecting, hiding, deleting, applying interest area templates) collectively. This message must be sent after TRIAL_VAR_LABELS message but before first trial start message in EDF file.

Format:
`V_TRIAL_GROUPING  <trial variable list>`
The trial grouping variable(s) must be a member of the variables listed in the TRIAL_VAR_LABELS; otherwise, this variable is simply ignored.

Example:

```
MSG   3363553 V_TRIAL_GROUPING  TYPE   DIRECTION
```

Note: Trial variables are space delimited. Trial variables that do not exist in variable list for trial are ignored.

7.3 Trial Message Commands

The following message commands MUST be specified within the scope of a trial, or the message commands will not be interpreted by the viewer.

IMPORTANT: All message commands within the trial scope must start with a !V directive, or the command will not be interpreted and will instead appear as a regular message in the visible message list of the viewer.

Tip: In almost all instances, each of the following commands will be repeated for every trial of an EyeLink data file.

7.3.1 Trial Variable Values

Identifier (Default): TRIAL_VAR_DATA

Description:

This message specifies the list of trial variable values for the trial. The list of trial variable values must be in the same order as was specified in the TRIAL_VAR_LABELS command for the viewer to properly match the variable label with the variable value. The command identifier can be changed in the data loading preference settings.

Note: If this command is the same as the Trial Start Command (TRIALID), the values will still be extracted from the Trial Start Line; however a !V is not needed in the message.

Format:

```
!V  TRIAL_VAR_DATA  <trial_variable_list>
```

Example:

```
MSG   3363553 !V TRIAL_VAR_DATA value1 value2 value3
```

7.3.2 Single Trial Variable Message Token

Identifier (Default): TRIAL_VAR

Description:

This command lets the user specify a trial variable and value for the given trial. Send one message for each pair of trial condition variable and its corresponding value. This means that there is really no need to use TRIAL_VAR_LABELS command when using this command. The default command identifier can be changed in the data loading preference settings. Please note that the eye tracker can handle about 20 messages every 10 milliseconds. So be careful not to send messages too quickly when you have many trial condition messages to send. Add one millisecond delay between message lines if this is the case.

Format:

```
!V  TRIAL_VAR <trial_var_label> <trial_var_value>
```

<trial_var_label> is the label for the variable being set. If the current Data Viewer session does not have this variable yet, it is created. <trial_var_value> defines the value to set for the variable for the given trial.

Example:

```
MSG   9350338 !V TRIAL_VAR trial 1
MSG   9350339 !V TRIAL_VAR condition gap
MSG   9350340 !V TRIAL_VAR direction Left
MSG   9350341 !V TRIAL_VAR gap_duration 200
MSG   9350342 !V TRIAL_VAR t_x 212
MSG   9350343 !V TRIAL_VAR t_y 384
```

7.3.3 Image Commands

The viewer supports a set of commands that display a default image on the overlay mode of the trial viewer screen. All image commands use the IMGLOAD token, followed by a sub command.

7.3.3.1 Image Loading – Fill Full Screen

Identifier: FILL

Description:

This message specifies the image to be used as the background for the spatial overlay view of a trial within the viewer. The image is sized to fit the dimensions specified in the DISPLAY_COORDS command message. The image should be represented as a relative path. The viewer will look for the image in the following order:

1) In the default image directory specified in the general preference settings.
2) In the directory the EyeLink data file is loaded from.
3) In the directory the viewer application is running from.

Format:

```
!V  IMGLOAD  FILL  <relative_image_path>
```

Example:

```
MSG   3388468 !V IMGLOAD FILL Sac_blur.jpg
```

7.3.3.2 Image Loading – Top Left

Identifier: TOP_LEFT

Description:

This message specifies an image to be used as a segment of the spatial overlay view of a trial within the viewer. The image size is not changed (unless width and height parameters are also specified) and will be positioned by using the x and y positions specified as the top left corner of the image. The image should be represented as a relative path. The viewer will look for the image in the following order:

1) In the default image directory specified in the general preference settings.
2) In the directory the EyeLink data file is loaded from.
3) In the directory the viewer application is running from.

Format:

```
!V  IMGLOAD  TOP_LEFT  <relative_image_path>  <x_position>
      <y_position>  [width]  [height]
```

Note: width and height are optional parameters

Example:

```
MSG 2740540 !V IMGLOAD TOP_LEFT fixations.gif 200 200
```

7.3.3.3 Image Loading – Centered

Identifier: CENTER

Description:

This message specifies an image to be used as a segment of the spatial overlay view of a trial within the viewer. The image size is not changed (unless width and height parameters are specified) and will be positioned centering on the x-y coordinate specified. The image should be represented as a relative path. The viewer will look for the image in the following order:

1) In the default image directory specified in the general preference settings.
2) In the directory the EyeLink data file is loaded from.
3) In the directory the viewer application is running from.

Format:

```
!V  IMGLOAD  CENTER  <relative_image_path>  <x_position>  <y_position>
      [width]  [height]
```

Example:

```
MSG 2740540 !V IMGLOAD CENTER  fixations.gif 200 200
```

7.3.4 Simple Drawing

Besides the image loading, the viewer also supports a set of commands that draws simple graphics, such as lines, framed box, filled box, as well as display clearing.

7.3.4.1 Clear Overlay View

Identifier: CLEAR

Description:

This command clears the overlay view to the color specified by the red, blue, green integer values specified in the command. Each RGB value should be an integer between 0 and 255.

Format:

```
!V  CLEAR  <red>  <blue>  <green>
```

Example:

```
MSG 2740540 !V CLEAR 255 255 255
```

This clears the display to white color.

7.3.4.2 Line drawing

Identifier: DRAWLINE

Description:

This command draws a line with the color specified by the red, blue, green integer values specified in the command. Each RGB value should be an integer between 0 and 255.

Format:

```
!V  DRAWLINE  <red>  <blue>  <green> <x_start>  <y_start>  <x_end>
      <y_end>
```

Note: <x_start>: x-coordinate of the starting point; <y_start>: y-coordinate of the starting point; <x_end>: x-coordinate of the end position; <y_end>: y-coordinate of the ending position.

Example:

```
MSG    9441901 !V DRAWLINE 255 0 0 100 100 300 400
```

This draws a red line, connecting (100, 100) and (300, 400).

7.3.4.3 Drawing a Rectangle

Identifier: DRAWBOX

Description:

This command draws a framed rectangle with the color specified by the red, blue, green integer values specified in the command. Each RGB value should be an integer between 0 and 255.

Format:

```
!V  DRAWBOX  <red>  <blue>  <green> <top>  <left>  <right>  <bottom>
```

Note: Left, top, right, and bottom refer to the x-y coordinates of the top-left and bottom-right corners of rectangle.

Example:
```
MSG    9441901 !V DRAWBOX 0 255 0 200 300 400 500
```

This draws a green rectangle (frame), with the top-left corner at (200, 300) and the bottom-right corner at (400, 500).

7.3.4.4 Drawing a Filled Rectangle

Identifier: FILLBOX

Description:

This command draws a filled rectangle with the color specified by the red, blue, green integer values specified in the command. Each RGB value should be an integer between 0 and 255.

Format:

```
!V  FILLBOX  <red>  <blue>  <green> <top>  <left>  <right>  <bottom>
```

Note: Left, top, right, and bottom refer to the x-y coordinates of the top-left and bottom-right corners of rectangle.

Example:
```
MSG    9441901 !V FILLBOX 0 0 255 400 500 500 600
```

This draws a rectangle, with the top-left corner at (400, 500) and the bottom-right corner at (500, 600). The rectangle is filled with the blue color.

7.3.4.5 Drawing a Fixation Point

Identifier: FIXPOINT

Description:

This command draws a fixation point at a specified position.

Format:

```
!V  FIXPOINT  <target_red>  <target_blue>  <target_green>   <erase_red>
      <erase_green> <erase_blue>  <x>  <y>  <outer_diameter>
      <inner_diameter>
```

Note: The RGB values for the fixation point drawing color is specified by the <target_red> <target_blue> <target_green> whereas the color of the fixation center is specified by <erase_red> <erase_green> <erase_blue>. The <outer_diameter> and <inner_diameter> specified the diameters of the drawing circles.

Example:

```
MSG    9441901 !V FIXPOINT 0 0 0 255 255 255 511 383 18 4
```

This draws a fixation point at (511, 383), with a diameter of 18 pixels for the outer ring and 4 pixels for the inner ring. The fixation point is drawn in black and its center is erased with white.

7.3.4.6 Draw List File

Identifier: DRAW_LIST

Description:

When a large number of simple drawings have to be made, it is easier to first record all of the simple drawings in a draw list file. During the viewing session, the viewer reads in the drawing commands from the pre-recorded file and re-creates the display drawing. In a draw list file (.dlf), each line represents one simple drawing or an image loading command written in the same format as mentioned above except that "!V" directive is not necessary.

Format:

```
!V DRAW_LIST <relative path>
```

Example:

```
Example: MSG 262495 !V DRAW_LIST BER\s1106.dlf
```

The content of the file being:

```
CLEAR 255 255 255
IMGLOAD TOP_LEFT BER\color.bmp 772 644 33 33
IMGLOAD TOP_LEFT BER\shape.bmp 772 314 33 33
IMGLOAD TOP_LEFT BER\orient.bmp 222 424 33 33
IMGLOAD TOP_LEFT BER\color.bmp 552 94 33 33
```

This first clears the display and then loads four small bitmap images.

7.3.5 Interest Area Commands

The viewer supports a set of interest area commands that inform the viewer what interest areas to create by default for a given trial. Trials that have interest area commands specified in the data file have a custom interest area set created when the data is loaded containing the specified interest areas.

All interest area commands start with the IAREA token and are followed by a one word sub command.

7.3.5.1 Rectangular Interest Area

Identifier (Default): RECTANGLE

Description:

This message specifies the attributes of a rectangular interest area for the trial. Each trial can have a set of such rectangular interest areas.

Format:

```
!V  IAREA  RECTANGLE  <id>  <left>  <top>  <right>  <bottom> [label
      string]
```

Note: The label string parameter is optional.

Example:

```
MSG 2740540 !VIAREA RECTANGLE 154   547   410   585   449
```

7.3.5.2 Elliptic Interest Area

Identifier (Default): ELLIPSE
Description:

This message specifies the attributes of an elliptic interest area for the trial. Each trial can have a set of such elliptic interest areas.

Format:

```
!V  IAREA  ELLIPSE  <id>  <left>  <top>  <right>  <bottom>  [label
string]
```

Note: The label string parameter is optional. Left, top, right, and bottom refer to the x-y coordinates of the top-left and bottom-right corners of the bounding rectangle.

Example:

```
MSG 2740540 !V    IAREA ELLIPSE 154       547   410   585   449
```

7.3.5.3 Freehand Interest Area

Identifier (Default): FREEHAND

Description:

This message specifies the attributes of a freehand interest area for the trial. Each trial can have a set of such freehand interest areas.

Format:

!V IAREA FREEHAND <id> $<x_1,y_1>$ $<x_2,y_2>$ ... $<x_n,y_n>$ [label string]

Note: The label string parameter is optional. x_n, y_n refers to the x, y coordinates of a point. The x, y coordinates of each point are separated by a comma.

Example:

```
MSG 2740540 !V IAREA FREEHAND 100,200 300,400 500,600 200,300 label
text
```

7.3.5.4 Interest Area Set

Identifier (Default): FILE

Description:

When a large number of interest areas have to be specified (such as in reading research), it is easier to first write all the interest area information in a text file and later on the Viewer can locate and import the interest-area file. The `!V IAREA FILE` serves this purpose. In an interest-area file, each line represents one interest area, recorded in the format of "RECTANGLE id left top right bottom [label]" for a rectangular interest area, "ELLIPSE id left top right bottom [label]" for an elliptic interest area, and "FREEHAND id x_1, y_1 x_2, y_2 ... x_n, y_n [label]" for a freehand interest area.

Format:

```
!V  IAREA  FILE  <relative_file_path>
```

Example:

```
MSG 2740540 !V    IAREA FILE  segments\example.ias
```

7.3.6 Target Position Commands

For experiments in which a moving resource is used, the user may need to keep track of the position of the resource. The Data Viewer allows the user to calculate the position, velocity, and acceleration data for each individual samples in the sample output report. With such messages, position, velocity, and acceleration traces can be displayed in the time plot view.

Identifier (Default): `TARGET_POS`

Description:

This message specifies the position and visibility of the targets at the specific message time. The command identifier can be changed in the data loading preference settings.

Format:

```
!V TARGET_POS <Target1 Key> <(target1 x, target1 y)> <target 1
    visibility> <target 1 step> <Target2 Key> <(target2 x, target2
    y)> <target 2 visibility> <target 2 step>
Where <Target1 Key> and <Target2 Key>: the tokens to extract the
    position(s) of target(s);
    <(target1 x, target1 y)> and <(target2 x, target2 y)>: the
    position(s) of the targets.  The coordinates must be enclosed in
    a pair of brackets;
    <target 1 visibility> and <target 2 visibility>: if 1, the
    targets are visible; if 0, the targets are hidden;
    <target 1 step> and <target 2 step>: if 1, the position of the
    target will be in steps; if 0, the position of the target is
    interpolated across samples.
```

Example:

```
MSG   9071000 -15 !V TARGET_POS TARG1 (351, 278) 1 0; TARG2 (590, 134)
1 0
```

Note: The user can use any token word to indicate the target ID. The "key" property of the temporal graph preference settings is set to blank by default so that various token words can be used. If two targets are involved and if the order of the two targets is important, set that field to the token strings used in the target position command string.

7.4 Reaction Time Definitions

To obtain an accurate reaction time (RT) measure, the EyeLink Data Viewer relies on a set of reaction time definitions to parse the start and end events for RT calculation. The reaction time definition command messages inform the Viewer of the RT start message, the type of RT end events (fixation, saccade, message, or button), the parameters of the end event, as well as the conditions to which the RT definition is applied. Reaction time definition commands can be provided in two ways. The user can employ a pre-trial (condition-based) command messages to specify a RT definition for each of the experimental condition. All pre-trial reaction time commands start with the V_RT token and are followed by a one word subcommand, indicating the type of RT end event (BUTTON, MESSAGE, FIXATION, or SACCADE). Alternatively, the user can supply a custom reaction time definition specifically for each trial. All custom trial-specific reaction time commands start with the !V V_CRT token and are followed by a one word subcommand.

Important: When an EyeLink Data File is loaded into the Viewer, any existing Reaction Time Definitions for the Data Viewing Session are removed and reloaded from the data file being imported. Therefore, it is important that each data file contain all the pre-trial (condition-based) command messages required for the full analysis, not just for the given data file. Any previously set custom, trial specific, reaction time definitions are not affected when a new data file is loaded.

7.4.1 Button Events

Identifier: BUTTON

Description:

This will treat a particular button press/release as the reaction time end event.

Pre-Trial Message Command Format:

```
V_RT  BUTTON  <rt_start_msg>  <button_id>  <state>  [CONDITION LABEL 1]
      [condition value 1]  [CONDITION LABEL 2]  [condition value 2] …
```

Trial-specific Message Command Format:

```
!V  V_CRT  BUTTON  <rt_start_msg>  <button_id>  <state>
```

Note: Button_id refers to the intended button ID (from 1 to 8, use 0 for any button event). Button state could be 0 (button release) or 1 (button press). Condition labels and their values are not required for the trial-specific message command and optional for the pre-trial message command (if not specified, the RT definition is applied to all conditions). In case both a condition-based pre-trial message command and a custom trial specific message command are applicable for one trial, the trial-specific command will override the more general one.

Example:

```
MSG 329381 V_RT BUTTON SYNCTIME 5 1 TYPE normal
```

In this example, the end event for RT calculation is pressing button 5 serves. This RT definition is applicable to the condition in which the value of the variable TYPE is "normal".

7.4.2 Fixation Events:

Identifier: FIXATION

Description:

This will end the trial by the appearance of a specific fixation. The user can specify the parameters of the fixation end event: the minimum fixation duration (in milliseconds) required, the *xy* coordinates for the region center, as well as the diameter of the fixation region.

Pre-Trial Message Command Format:

```
V_RT  FIXATION  <rt_start_msg>  <fixation_duration>  <x>  <y>
      <diameter>  [CONDITION LABEL 1]  [condition value 1]  [CONDITION
      LABEL 2]  [condition value 2] …
```

Trial-specific Message Command Format:

```
!V  V_CRT  FIXATION  <rt_start_msg>  <fixation_duration>  <x>  <y>
      <diameter>
```

Note: If the location information of the target fixation is not important, set the values of *x*, *y*, and diameter as -1. Condition labels and their values are not required for the trial-specific message command and optional for the pre-trial message command (if not specified, the RT definition is applied to all conditions).

Example:

```
MSG 329381 V_RT FIXATION SYNCTIME 500 -1 -1 -1
```

In this example, the RT end event is the occurrence of the first fixation with a minimum duration of 500 milliseconds whereas the location information of the fixation is not important.

7.4.3 Saccade Events:

Identifier: SACCADE

Description:

This will end the trial by the appearance of a specific saccade. The user can specify the parameters of the saccade end event: the minimum saccadic amplitude (in degrees of visual angle) required, the *xy* coordinates for the region center, as well as the diameter of the fixation region.

Pre-Trial Message Command Format:

```
V_RT SACCADE <rt_start_msg>  <saccadic_amplitude>  <x>  <y>  <diameter>
      [CONDITION LABEL 1]  [condition value 1]  [CONDITION LABEL 2]
      [condition value 2] …
```

Trial-specific Message Command Format:

```
!V  V_CRT  SACCADE  <rt_start_msg>  <saccadic_amplitude>  <x>  <y>
      <diameter>
```

Note: If the location information of the saccade is not important, set the values of *x*, *y*, and diameter as -1. Condition labels and their values are not required for the trial-specific message command and optional for the pre-trial message command (if not specified, the RT definition is applied to all conditions).

Example:

```
MSG 329381 V_RT SACCADE SYNCTIME 5.0 300 400 100 TYPE Normal
```

In this example, the RT end event is the occurrence of the first saccade with a minimum amplitude of 5.0 degrees of visual angle. The saccade must fall within 50 pixels from the region center (300, 400).

7.4.4 Message Events:

Identifier: MESSAGE

Description:

This will treat the first occurrence of a matching message as the end event for reaction time calculation.

Pre-Trial Message Command Format:

```
V_RT  MESSAGE  <rt_start_msg>  <rt_end_msg>  [CONDITION LABEL 1]
      [condition value 1] [CONDITION LABEL 2] [condition value 2] …
```

Trial-specific Message Command Format:

```
!V  V_CRT  MESSAGE  <rt_start_msg>  <rt_end_msg>
```

Note: Condition labels and their values are not required for the trial-specific message command and optional for the pre-trial message command (if not specified, the RT definition is applied to all conditions).

Example:

```
MSG 329381 V_RT MESSAGE SYNCTIME END_RT
```

7.4.5 Reaction Time Definition Set

Identifier: FILE

Description:

When a large number of RT definitions have to be specified, it is easier to first record all RT definitions in a file and later on the viewer can read the RT definition file with the V_RT FILE command. In a reaction-time definition file, each line represents one RT definition, which is written in the same format as the pre-trial message command for each respective type of RT end event, except that in this case V_RT token is not necessary.

Pre-Trial Message Command Format:

```
V_RT  FILE  <relative path>
```

Example:

```
MSG 329381 V_RT FILE rt\default.rts
```

7.5 Changes in the Sample Experiments

The preceding sections list the special messages and commands that can be sent to the EDF file to enable the EyeLink Data Viewer to extract information in a more efficient way. The current section provides an overview of the changes made in the sample experiment templates. Please refer to the "Programming EyeLink Experiments in Windows Version 2.0" manual for the description of individual templates.

7.5.1 "Simple" Template

Two EyeLink Data Viewer commands have been introduced in the "Simple" template: "TRIAL_VAR_LABELS" for the definition of the labels to be used for trial condition variables within the viewer and "TRIAL_VAR_DATA" for the assignment of condition values for each trial. All these changes, listed in the following table, were made in the w32_simple_trials.c file of the template.

Data Viewer Functionality	Message Commands
Trial Variable Labels	eyemsg_printf("TRIAL_VAR_LABELS TRIAL_WORD");
Trial Variable Values	eyemsg_printf("!V TRIAL_VAR_DATA %s", trial_word[num-1]);

7.5.2 "Text" Template

Along with the "TRIAL_VAR_LABELS" and "TRIAL_VAR_DATA" commands, the "Text" template also uses "IMGLOAD FILL" to load a single image and "IAREA FILE" to import a file containing interest areas for the trial. All of these changes, listed in the following table, were made in the w32_text_trials.c file of the template.

Data Viewer Functionality	Message Commands

Trial Variable Labels	eyemsg_printf("TRIAL_VAR_LABELS PAGE");
Trial Variable Values	eyemsg_printf("!V TRIAL_VAR_DATA %d", num);
Images	eyemsg_printf("!V IMGLOAD FILL Images/%s", image_fn);
Interest Areas	eyemsg_printf("!V IAREA FILE Segments/%s", seg_fn);

7.5.3 "Picture" Template

One new feature of the "Picture" template is the demonstration of another approach to load images and to specify interest areas for the trial. The third trial of the template loads individual images (IMGLOAD TOP_LEFT) to create a composite image in the Viewer and reads individual rectangular interest areas directly ("IAREA RECTANGLE"). All these changes, listed in the following table, were made in the w32_picture_trials.c file of the template.

Data Viewer Functionality	Message Commands
Trial Variable Labels	eyemsg_printf("TRIAL_VAR_LABELS TYPE");
Trial Variable Values	eyemsg_printf("!V TRIAL_VAR_DATA %s", imgname[num-1]);
Images	
"Normal" image	eyemsg_printf("!V IMGLOAD FILL images/sacrmeto.jpg");
"Blurred" image	eyemsg_printf("!V IMGLOAD FILL images/sac_blur.jpg");
"Composite" image	eyemsg_printf("!V IMGLOAD TOP_LEFT %s %d %d %d %d", small_images[i], points[i].x, points[i].y, SCRWIDTH/2, SCRHEIGHT/2);
Interest Areas	
"Composite" image	eyemsg_printf("!V IAREA RECTANGLE %d %d %d %d %d %s", i+1, points[i].x, points[i].y, points[i].x + SCRWIDTH/2, points[i].y + SCRHEIGHT/2, small_images[i]);

7.5.4 "EyeData" Template

The following table lists all of the changes made to the w32_data_trials.c file of the "EyeData" template.

Data Viewer Functionality	Message Commands
Trial Variable Labels	eyemsg_printf("TRIAL_VAR_LABELS CONDITION");
Trial Variable Values	eyemsg_printf("!V TRIAL_VAR_DATA Playback");
Images	eyemsg_printf("!V IMGLOAD FILL images/grid.png");
Interest Areas	eyemsg_printf("!V IAREA FILE segments/grid.ias");

7.5.5 "GCWindow" Template

The following table lists all of the changes made to the w32_gcwindow_trials.c file of the "GCWindow" template.

Data Viewer Functionality	Message Commands
Trial Variable Labels	eyemsg_printf("TRIAL_VAR_LABELS TYPE CENTRAL PERIPHERAL");
Trial Variable Values	
Trial 1	eyemsg_printf("!V TRIAL_VAR_DATA TEXT TEXT MASK");
Trial 2	eyemsg_printf("!V TRIAL_VAR_DATA TEXT MASK TEXT");
Trial 3	eyemsg_printf("!V TRIAL_VAR_DATA IMAGE IMAGE MASK");
Trial 4	eyemsg_printf("!V TRIAL_VAR_DATA IMAGE MASK IMAGE");
Trial 5	eyemsg_printf("!V TRIAL_VAR_DATA IMAGE IMAGE BLURRED");
Images	
Trials 1 & 2	eyemsg_printf("!V IMGLOAD FILL images/text.png");
Trials 3, 4, & 5	eyemsg_printf("!V IMGLOAD FILL images/sacrmeto.jpg");
Interest Areas	
Trials 1 & 2	eyemsg_printf("!V IAREA FILE segments/text.ias");

7.5.6 "Control" Template

The following messages and commands have been added to the w32_control_trials.c file of the "Control" template.

Data Viewer Functionality	Message Commands
Trial Variable Labels	eyemsg_printf("TRIAL_VAR_LABELS CONDITION");

The following messages and commands have been added to the w32_control_trial.c file of the "Control" template.

Data Viewer Functionality	Message Commands
Trial Variable Values	eyemsg_printf("!V TRIAL_VAR_DATA GAZECTRL");
Images	eyemsg_printf("!V IMGLOAD FILL images/grid.png");
Interest Areas	eyemsg_printf("!V IAREA FILE segments/grid.ias");

7.5.7 "Dynamic" Template

One important feature introduced in the "Dynamic" template is the addition of custom reaction time definition (!V V_CRT") for the saccade trials. Reaction time is defined as the interval between the onset of the target ("SYNCTIME" message) and the occurrence of the first saccade, with a minimum amplitude of 2.0°, that falls within 50 pixels from the saccade target (*goal_x*, *goal_y*). The following table lists all of the messages and commands that have been added in the w32_data_trials.c file of the "Dynamic" template.

Data Viewer Functionality	Message Commands
Trial Variable Labels	eyemsg_printf("TRIAL_VAR_LABELS TRIAL TYPE DIRECTION");
Trial Variable Values	eyemsg_printf("!V TRIAL_VAR_DATA %d %s %s", num, trial_labels[0][num-1], trial_labels[1][num-1]);
Reaction Time Definitions	
Trials 3-8	eyemsg_printf("!V V_CRT SACCADE SYNCTIME 2.0 %d %d 50", goal_x, goal_y);

7.5.8 "Comm_simple" Template

Similar to the "Simple" template, "TRIAL_VAR_LABELS" and "TRIAL_VAR_DATA" commands were added to the w32_simple_trials.c file of the template (see the Table).

Data Viewer Functionality	Message Commands
Trial Variable Labels	eyemsg_printf("TRIAL_VAR_LABELS TRIAL_WORD");
Trial Variable Values	eyemsg_printf("!V TRIAL_VAR_DATA %s", trial_word[num-1]);

7.5.9 Other Templates

Since the "Broadcast" and "Comm_listener" templates do not produce EyeLink data recording, no change has been made in those templates to support Data Viewer analysis.

8 Tutorial: Visual Search

The current tutorial aimed to create an experiment following Williams and Reingold (2001) and perform similar analyses with the EyeLink Data Viewer.

8.1 Project Background Information

In a recent study by Williams and Reingold (2001), eye movements were monitored during the performance of a visual search task. Display items were created by combining features from three stimulus dimensions: color (red vs. blue), shape ("C" vs. "T" or "E" vs. "F"), and orientation (normal vs. rotated). Across trials, the target, counterbalanced across subjects, was either present or absent. Each displays consisted of 6, 12, or 24 items. Stimulus discriminability was manipulated for the shape dimension, with half of the participants seeing displays of "E"s and "F"s (low-discriminability condition) whereas the other half of the participants seeing displays of "C"s and "T"s (high-discriminability condition). Participants in both conditions performed two search tasks. In a "single-feature" (SF) task, the target stimulus shared one feature with each of the distractors, whereas in a "two-feature" (TF) task, it shared two features with each distractor.

Williams and Reingold (2001) investigated whether the conjunction search tasks are guided by certain feature(s) shared between the target and distractors. By examining the spatial distributions of the fixations, they found that participants were more likely to fixate on those distractors sharing color (SF task) or color and shape (TF task) with the target. This was a robust finding, being observed across participants, across saccades of different amplitudes and sequential position, and following short and long latencies to move. These investigators also found that the extent to which participants made use of shape information increased with discriminability.

8.2 Programming

The current experiment includes three individual projects: Gen_IAS for creating interest area set files, Gen_Rnd for generating randomization script files, and VisualSearch for running the actual experiment and integrating the Data Viewer functionalities.

8.2.1 Creating Interest Area Set Files

The Gen_IAS project creates interest area set files for the current visual search displays. The **`main()`** function in the Gen_IAS.c file marks the beginning of program execution. It is used to create 48 replicas of test trials (3 for practice trials) for each possible combination of target presence (target present vs. target absent), set size (6, 12, or 24 items in a display), feature (number of features shared between the search target and distractors: one feature vs. two features) by calling the **`create_display()`** function. The **`save_display_info()`** function is used to save the interest area information into

a .ias file. Note that the eyelink_exptkit20.lib file must be included in the project to ensure the program running appropriately.

8.2.2 Generating Randomization Files

The Gen_Rnd project is used to generate randomization script files for individual subjects. The **`main()`** function takes two arguments, passing the subject id and discriminability information to the **`create_rnd_file()`** function. The latter function translates a sequence of random numbers generated by **`sequence()`** into trial condition information (target presence, set size, and stimulus number) and records it into a text (.rnd) file.

8.2.3 Programming the Visual Search Experiment

The current experiment is modified after the Picture template. Therefore, reading the description of the first three templates (Simple, Text, and Picture) of the "Programming EyeLink Experiments in Windows Version 2.0" manual will be helpful in understanding the source code of the current experiment.

8.2.3.1 Source Files for "VisualSearch"

The following table lists all of the files that are used to build VisualSearch. Those that are the same as for the Picture template are marked with an asterisk. Those files that have been modified are discussed in the following sections.

w32_demo.h *	Declarations to link together the template experiment files. Most of the declarations in this file can be used in your experiments.
w32_script_main.c (after w32_demo_main.c)	**`WinMain()`** function, setup and shutdown link and graphics, open EDF file, open a script file containing the trial randomization information.
w32_demo_window.c *	Implements the full-screen window used for calibration, validation and presentation. This file is unchanged for all templates, and can be used without changes in your experiments.
w32_script_trials.c (after w32_picture_trials.c)	Performs system setup at the start of each block, and then runs the trials with information read from the script file. Handles standard return codes from trials to allow trial skip, repeat, and experiment abort.
w32_bitmap_trial.c*	Implements a trial with simple graphics that can be drawn in one screen refresh, and therefore doesn't need display blanking. You should be able to use this by replacing the drawing code, message code, and handling any subject responses.
w32_text_support.c*	Implements a simple interface for font creation and

	printing. This is a support module that you can link into your experiments.
w32_freeimage_bitmap.c*	Loads any of a number of image file formats using the "freeimage" library, creating a device-dependent bitmap from it. The picture can be loaded to a bitmap matched in size, or a full-screen bitmap can be created and the image resized to fill it.
freeimage.h* freeimage.dll* freeimage.lib*	The "freeimage" library (www.6ixsoft.com). This is a freeware graphics file library.

8.2.3.2 w32_script_main.c

The w32_script_main.c file is modified after w32_demon_main.c. An explorer-style dialog is used to open the randomization script file for processing. To support this, the **OPENFILENAME** structure, which contains information that is used to initialize an Open/Save dialog box, is used. After the user closes the dialog, information about the user's selection is returned.

```
// Get the name of the script file
i = get_script_filename (full_screen_window, szFileName, szTitleName);
```

Once the script file name is retrieved, instead of calling the **run_trials()** function as in the w32_demon_main.c file, the current experiment calls the **run_script_trials()** function to run the experiment, with trial information read from the script file.

8.2.3.3 w32_script_trials.c

The w32_script_trials.c file is modified after the w32_picture_trials.c file of the Picture template. Essentially, this file calls the **process_script_file()** function to process the script file and extract the useful information for each trial (such as the title to be displayed at the bottom of the eyetracker display, trial conditions and bitmap, etc). The **do_script_trial()** function is used to execute each individual trial. The next section highlights all of the important messages and commands to be included in the EDF file to support the Viewer analysis.

8.2.4 Adding Data Viewer Functionalities

The current section lists all of the commands and messages that are important for the EyeLink Data Viewer analysis. All of these messages and commands are added in the

w32_script_trials.c file of the VisualSearch template. Reading the previous chapter of the current manual (section 7: Protocol for EyeLink Data to Viewer Integration) will be very helpful.

8.2.4.1 Trial Variable Labels

The TRIAL_VAR_LABELS message, included in the **`run_script_trials()`** function, allows the definition of the labels to be used for trial variables within the Viewer program. This message must be sent to the EyeLink data file prior to the first trial start message (such as "TRIALID", "TRIAL_VAR_DATA", etc.).

```
// TRIAL_VAR_LABELS message is recorded for EyeLink Data Viewer analysis
// It specifies the list of trial variables for the trial.
// This should be written once only and put before the recording of individual
// trials.

eyemsg_printf("TRIAL_VAR_LABELS TRIAL_FILENAME PRACTICE DISCRIMINABILITY
   FEATURES PRESENCE SETSIZE");
```

8.2.4.2 Trial ID and Trial

In the current example, the TRIALID message, included in the **`do_script_trial()`** function, defines the start of a trial for the Viewer. The Viewer will not parse any messages, events, or samples that exist in the data file prior to this message. The TRIAL_VAR_DATA message specifies the list of trial variable values for the trial (see section 7.3.1). Note that the list of trial variable values must be in the same order as was specified in the TRIAL_VAR_LABELS command for the viewer to properly match the variable label with the variable value.

```
// Given trial file name, execute trials
// Returns trial result code
// <filename_inf>: name of the trial ias filename
int do_script_trial(char *filename_inf)
{
int    i=0;
int    presence;     // target presence: 0 for absent and 1 for present
int    setsize;      // number of items in a display
int    features;     // number of features shared between the target and
                     // distractors: 0 for single-feature, 1 for two-feature;
int    practice;     // Whether the trial is a practice trial;
char   text[200], *token;
char   image_fn[200],  image_path[200];
                     // string to store the file and path names of the image

// Always send a TRIALID message before starting to record.
eyemsg_printf("TRIALID %s", filename_inf);

// Find the useful trial filename information from the string, removing the
// directory name
strcpy(text, filename_inf);
token = strtok( text, "\\");
token = strtok( NULL, "\\");
```

```
// Get the useful trial filename information from the string,
// removing the file extension
strcpy(text, token);
token = strtok( text, ".");

// From the filename, we get the information regarding the target presence,
// setsize, features, as well as whether it is a practice trial
presence  = token[1]-'0';
setsize   = token[2]-'0';
features  = token[3]-'0';
practice  = token[4]-'0';

// TRIAL_VAR_DATA message is recorded for EyeLink Data Viewer analysis
// It specifies the list of trial variables value for the trial
// This must be specified within the scope of an individual trial (i.e., after
// "TRIALID" and before "TRIAL_RESULT")
eyemsg_printf("!V TRIAL_VAR_DATA %s %s %s %s %s %d",
       token,
       practice?"Practice":"TestTrial",
       discriminability?"High_discriminability":"Low_discriminability",
       features?"Two_feature":"Single_feature",
       presence?"Present":"Absent",
       items[setsize]);
```

8.2.4.3 Trial Bitmap

The spatial overlay view allows a trial to be viewed superimposed on the background image that the participant was looking at while the data was being recorded. The Data Viewer loads the background image with the IMGLOAD token, followed by a FILL, TOP_LEFT, or CENTER subcommand. The trial image file name and its default path can be written to the EDF file.

```
// With such information, we now can create our image file name
// here we set the image file as .jpg file

sprintf(image_fn, "%s.jpg", token);

// Create image file directory for writing
if (discriminability)
       sprintf(image_path, "Images\\HD_%c%c%c\\", target_color?'B':'R',
              target_shape?'T':'C', target_orientation?'R':'N');
else
       sprintf(image_path, "Images\\LD_%c%c%c\\", target_color?'B':'R',
              target_shape?'F':'E', target_orientation?'R':'N');

// IMGLOAD command is recorded for EyeLink Data Viewer analysis
// It displays a default image on the overlay mode of the trial viewer screen.
// Writes the image filename + path info
eyemsg_printf("!V IMGLOAD FILL %s%s", image_path, image_fn);
```

The current experiment uses the **`bitmap_save_and_backdrop()`** function to transfer the trial bitmap to the tracker PC as backdrop for gaze cursors. This function also saves the bitmap as a JPEG file in the specified path ("images\\"). Please note that the file

saving option can be manipulated so that the existing files can be either overwritten (set the **sv_options** as 0) or not overwritten (SV_NOREPLACE).

```
// Save bitmap and transfer to the tracker pc.
// Since it takes a long to save the bitmap to the file, the
// value of sv_options should be set as SV_NOREPLACE
bitmap_save_and_backdrop(bitmap, 0, 0, 0, 0,  image_fn, image_path,
       SV_NOREPLACE, 0, 0, BX_MAXCONTRAST|(is_eyelink2?0:BX_GRAYSCALE));
```

8.2.4.4 Interest Area

Similarly, interest areas can be created for each trial, specifying the *x, y* coordinates for each individual display item as well as its label. In the current example, we recorded the item type (i.e., features shared with the search target) as the interest area label. Since the interest area set file has already been created in the Gen_IAS project (see section 8.2.1), we only need to add a command IAREA FILE to inform the Viewer to load the interest areas from the specified file during the viewing session.

```
// IAREA command is recorded for EyeLink Data Viewer analysis
// It creates a set of interest areas by reading the segment files
// Writes segmentation filename + path info
eyemsg_printf("!V IAREA FILE %s", seg_file_name);

// Must be offline to draw to EyeLink screen
set_offline_mode();

// Now we want to create the bitmap for the trial and save
// the segmentation information
// To avoid overwriting the file, we set the saving option as "SV_NOREPLACE"

if (create_image_bitmaps(filename_inf, seg_fn, SV_NOREPLACE))
{
       eyemsg_printf("ERROR: could not create bitmap");
       return SKIP_TRIAL;   // Skip the trial
}
```

8.3 Data Analysis

After the experiment is tested on a few subjects and data are collected, EyeLink Data Viewer can be used to perform analysis. To illustrate the functionality of the Viewer program, the current tutorial examined the data from one subject in detail.

8.3.1 Viewing session Manipulation and Data Loading

To create a Data Viewing Session (DVS), click on the EyeLinkDV.exe file. Once the program starts, click File → New from the menu bar or the button on the standard toolbar.

Once an viewing session is created, data files can be loaded by choosing:

File → Import Data → EyeLink File(s)

from the application menu bar (or clicking the button on the standard toolbar). In the Load dialog, go to the directory of the EDF files that you want to import and select the file(s). Multiple data files (i.e., EDF files) can be loaded into one viewing session. By default, the top-panel of the inspector window lists all of the data files ( ) loaded into the current viewing session (i.e., the trials in the viewing session were grouped by data file; see section 4.1.1.2 on Trial grouping). A trial group can be removed from the viewing session by selecting the node, clicking the right mouse, and choosing the "Delete" option.

Important: Whether or not to load multiple EDF files into a viewing session depends on the user's choice of analysis outputs. Some statistical packages may not be able to handle the analysis output from all the EDF files recorded for one experiment, if each EDF file contains lots of trials and a large number of events/variables are extracted from the analysis. In this case, it is advised that the user load one or few EDF files into each viewing session. The current tutorial illustrated the case of loading one EDF file to one viewing session.

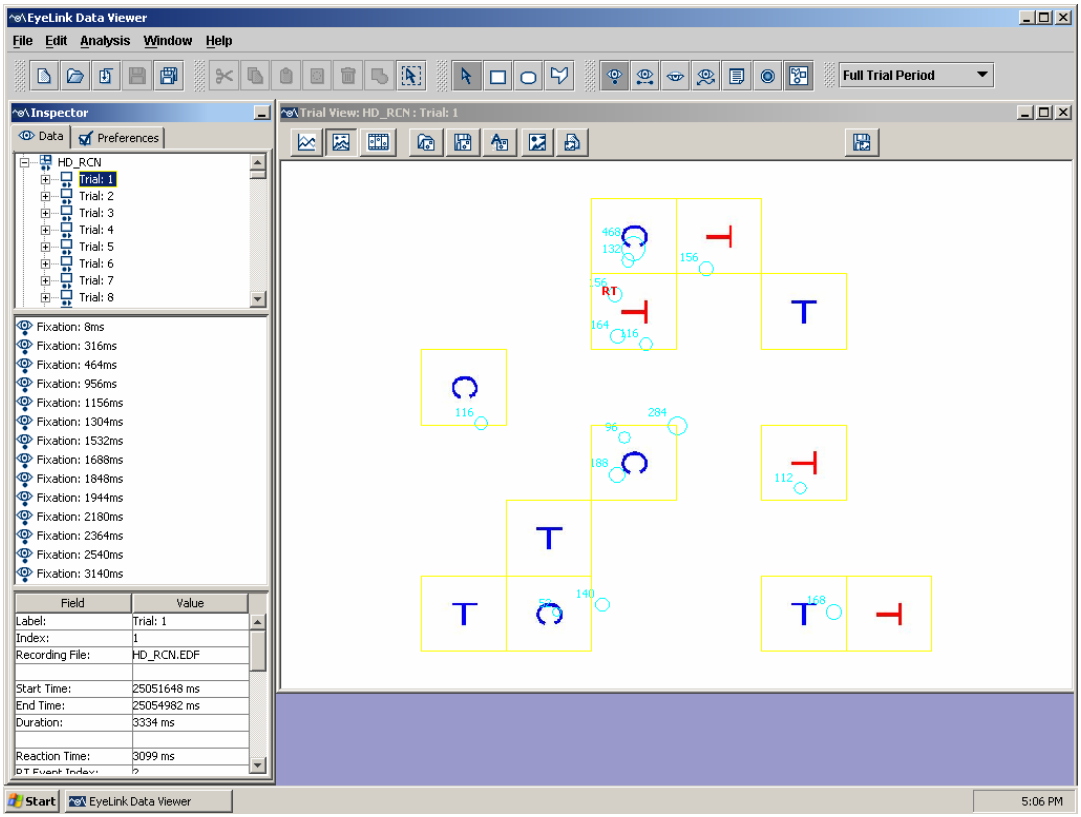


Figure 8-1. The first Viewer Screen after Loading HD_RCN.EDF file.

For the current tutorial, load the HD_RCN.EDF file from the VisualSearch directory (the search target for that subject was an upright red C). The first screen following the data loading should look like the one below (see Figure 8-2).

At any time, the viewing session can be saved by clicking File → Save from the application menu bar (or File → Save As for a different viewing session name). In the Save dialog box, enter the desired viewing session name (see Figure 8-3).

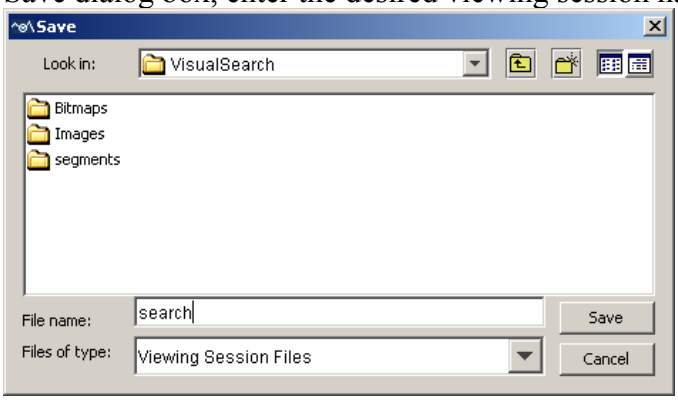


Figure 8-2. Saving a Viewer Viewing session.

A saved viewing session can be reloaded by clicking File → Open from the menu bar (or clicking the button on the toolbar) and selecting the desired .evs file from the open dialog box.

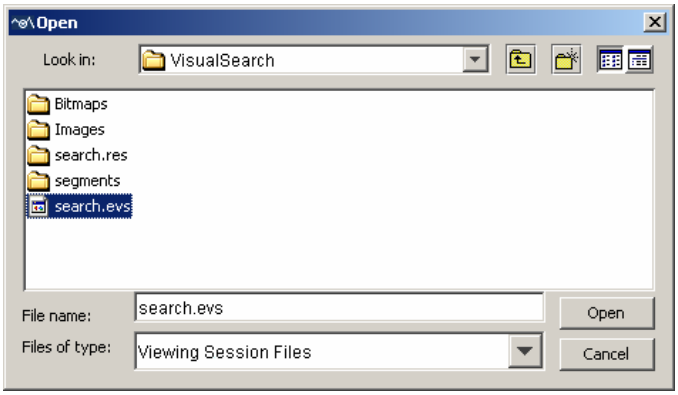


Figure 8-3. Opening a Saved Viewer Viewing session.

8.3.2 Trial Manipulation

By clicking on the trial nodes ( ) contained within a data file, information on participant's performance in individual trials can be examined (see section 4.1.1.3). As explained in chapter 4, the trial view window consists of two viewing modes (i.e., spatial overlay view and temporal graph view) whereas the inspector window provides the list of visible events in the trial (middle panel) and a summary of the trial performance (bottom panel). A selected trial can be deleted by clicking the right mouse button and selecting

the “Delete” option on the popup menu. Once the trial is deleted, it is removed from the viewing session and from all of the analysis outputs.

8.3.2.1 Loading Trial Bitmap

In the current example, the !V IMGLOAD FILL command loads the specified image to be used as the background for the spatial overlay view of a trial. When working with old EyeLink data recordings, the user can load a desired trial bitmap by clicking the “change the overlay image” button from the menu bar of the trial spatial overlay view window. The Data Viewer also allows the user to create a screen capture of the spatial overlay view or the temporal graph view of a given trial by clicking on the “Save Trial View as Image” button (see Figure 8-4).

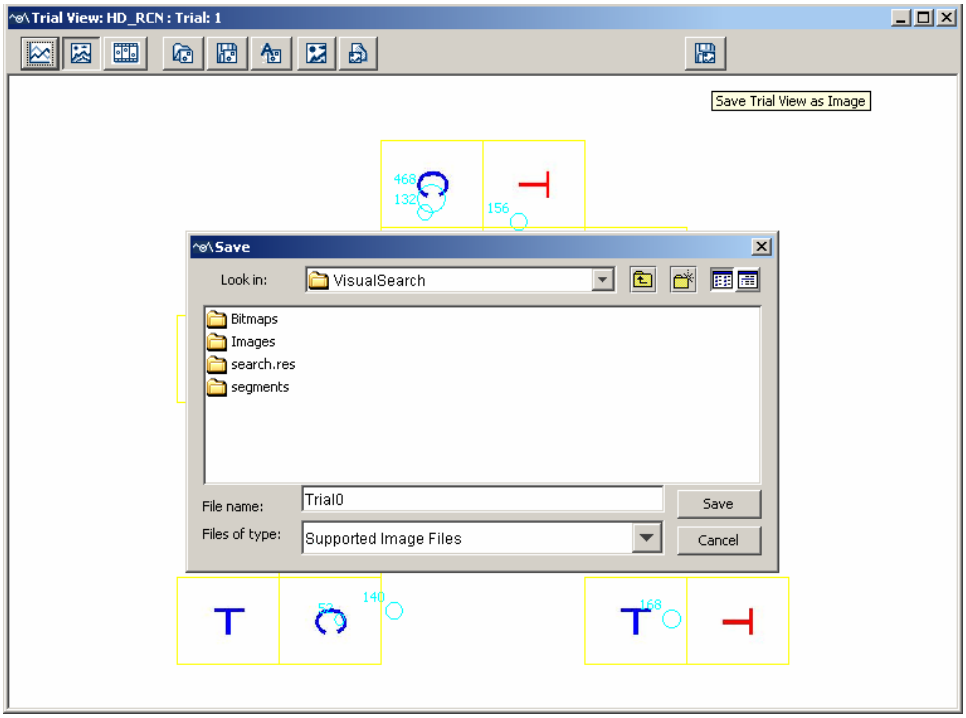


Figure 8-4. Creating a Screen Capture of the Spatial Overlay View or the Temporal Graph View of a Trial.

8.3.2.2 Loading Trial Interest Area Set

Similarly, the !V IAREA FILE command loads a specified interest area set file and segments the display according to the interest areas listed in the file. If the IAREA command was not initially recorded in the data file, the trial interest areas can be created in three ways. The first one is to load an interest area file or interest area template file by clicking the “Import Area of Interest File” button. In the Load dialog, select the desired interest area set file. The second approach is to allow the viewer to create interest areas, if a trial bitmap has already been loaded into the Viewer, by clicking the “Auto

Segment Image to Interest Area" button ( ). This approach is applicable for those displays in which the individual items can be easily isolated (such as in reading and visual search studies) but probably not good for some visual scenes in which the boundaries between individual elements are not easily defined. A third approach is to create interest areas manually by following the procedure outlined in section 5.8.1 "Creating Interest Areas". The created interested areas (by auto-segmentation or manually) can be saved by clicking the "Save the Interest Area Set File" button from the menu bar of the trial spatial overlay view window.

8.3.2.3 Manipulating Trial Condition Variables

The EyeLink Data Viewer allows the user to manage a list of trial condition variables and assign values for these variables in a given trial (see section 6.1). In the current example, the TRIAL_VAR_LABEL command imports a list of trial condition variables and the TRIAL_VAR_DATA command extracts the values for these variables (these two default messages can be changed in the data loading preference settings; see section 9.2). To review and manage the list of variables and assign default values for these variables, click Analysis → Trial Variable Manager from the application menu bar. To examine or change the values of the variables for a given trial, click Analysis → Trial Variable Value Editor.

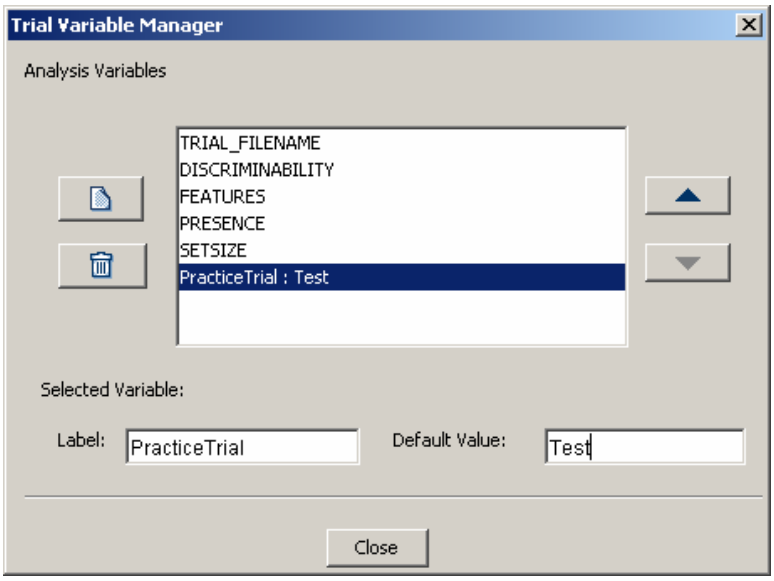
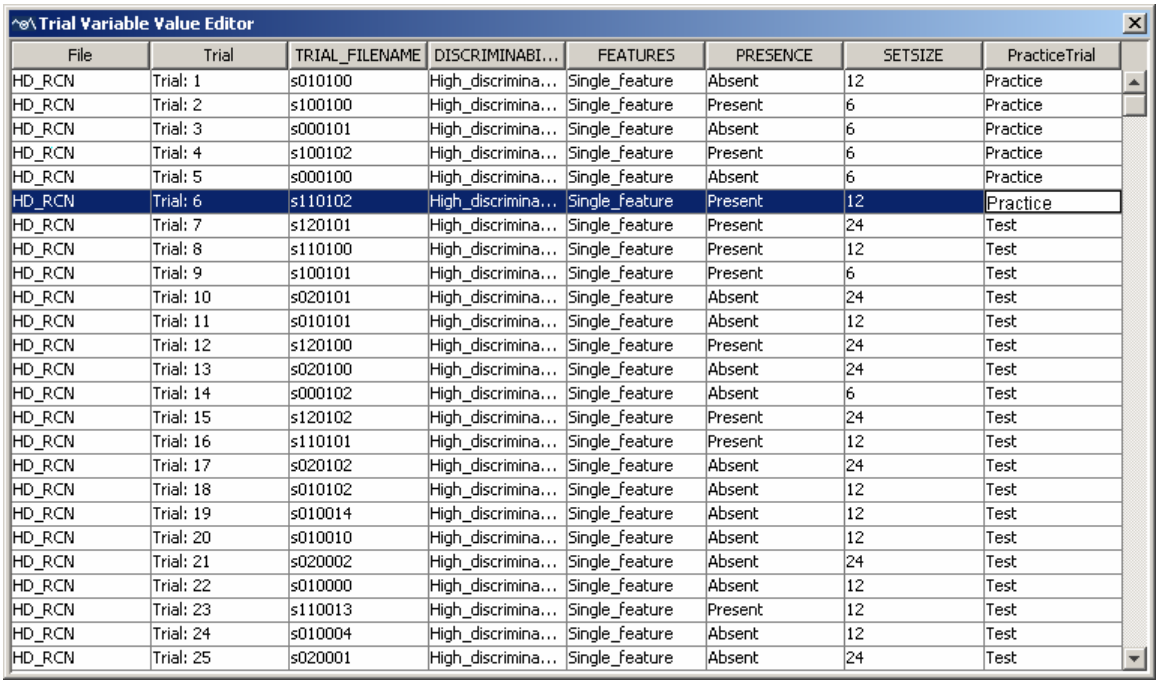


Figure 8-5. Using the Trial Variable Manager: Creating a New Variable

To demonstrate the functionality of the Trial Variable Manager, here we remove the "PRACTICE" variable and create a similar variable called "PracticeTrial". To remove a variable, simply select it and click the "Delete Selected Variable" button . To create a new variable, click the "New Variable" button . A new row titled "label: default value" is added to the variable list. To edit the label of the new variable, select it and type in

PracticeTrial in Label edit box and press the enter key. To assign a default value for that variable, type in *Test* and press the enter key (see Figure 8-6).

Now in the Trial Variable Value Editor dialog, we will see that for all trials, the values for the new variable "PracticeTrial" are set as "Test" (see Figure 8-6). We know that Trial 1-18 and Trial 115-132 were practice trials. To change the values for those trials, double click on the current cell value, type in *Practice* and press the Enter key to register the change.


Trial Variable Value Editor

File	Trial	TRIAL_FILENAME	DISCRIMINABI...	FEATURES	PRESENCE	SETSIZE	PracticeTrial
HD_RCN	Trial: 1	s010100	High_discrimina...	Single_feature	Absent	12	Practice
HD_RCN	Trial: 2	s100100	High_discrimina...	Single_feature	Present	6	Practice
HD_RCN	Trial: 3	s000101	High_discrimina...	Single_feature	Absent	6	Practice
HD_RCN	Trial: 4	s100102	High_discrimina...	Single_feature	Present	6	Practice
HD_RCN	Trial: 5	s000100	High_discrimina...	Single_feature	Absent	6	Practice
HD_RCN	Trial: 6	s110102	High_discrimina...	Single_feature	Present	12	Practice
HD_RCN	Trial: 7	s120101	High_discrimina...	Single_feature	Present	24	Test
HD_RCN	Trial: 8	s110100	High_discrimina...	Single_feature	Present	12	Test
HD_RCN	Trial: 9	s100101	High_discrimina...	Single_feature	Present	6	Test
HD_RCN	Trial: 10	s020101	High_discrimina...	Single_feature	Absent	24	Test
HD_RCN	Trial: 11	s010101	High_discrimina...	Single_feature	Absent	12	Test
HD_RCN	Trial: 12	s120100	High_discrimina...	Single_feature	Present	24	Test
HD_RCN	Trial: 13	s020100	High_discrimina...	Single_feature	Absent	24	Test
HD_RCN	Trial: 14	s000102	High_discrimina...	Single_feature	Absent	6	Test
HD_RCN	Trial: 15	s120102	High_discrimina...	Single_feature	Present	24	Test
HD_RCN	Trial: 16	s110101	High_discrimina...	Single_feature	Present	12	Test
HD_RCN	Trial: 17	s020102	High_discrimina...	Single_feature	Absent	24	Test
HD_RCN	Trial: 18	s010102	High_discrimina...	Single_feature	Absent	12	Test
HD_RCN	Trial: 19	s010014	High_discrimina...	Single_feature	Absent	12	Test
HD_RCN	Trial: 20	s010010	High_discrimina...	Single_feature	Absent	12	Test
HD_RCN	Trial: 21	s020002	High_discrimina...	Single_feature	Absent	24	Test
HD_RCN	Trial: 22	s010000	High_discrimina...	Single_feature	Absent	12	Test
HD_RCN	Trial: 23	s110013	High_discrimina...	Single_feature	Present	12	Test
HD_RCN	Trial: 24	s010004	High_discrimina...	Single_feature	Absent	12	Test
HD_RCN	Trial: 25	s020001	High_discrimina...	Single_feature	Absent	24	Test

Figure 8-6. Using the Trial Variable Value Editor: Modifying a Default Value

In case an analysis is being conducted on an old EyeLink data file in which the trial conditions were recorded following the "TRIALID" or other message whereas the trial variable labels were not recorded, to enable the correct loading of trial condition values, the user has to change the preference settings of data loading (see Figure 8-7). Click the preference tab of the Inspector window and select the Data Loading node. The default value for the Trial Variable Values Message field is "TRIAL_VAR_DATA". Replace it with "TRIALID" (or other message following which the condition values for a trial were recorded) and press the enter key to register the change. Now select the Data Loading preference node again, click the right mouse button and select "Save Properties as Defaults". To enable this change to take effect, the user has to reload the data file again.

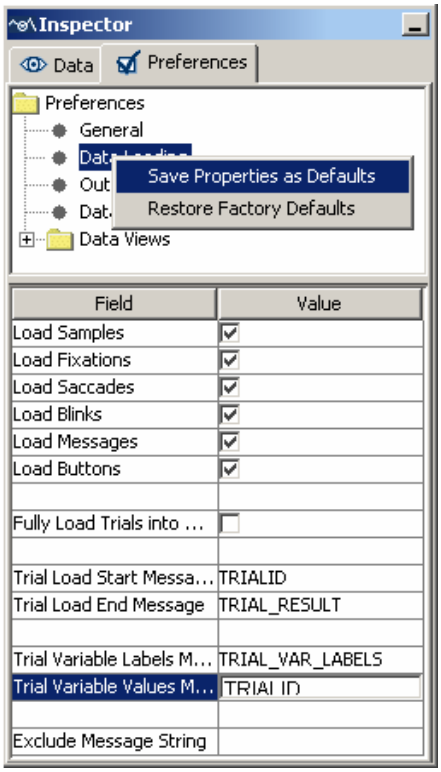


Figure 8-7. Modifying and Saving the Preference Setting of Data Loading.

Once the above changes have been applied and the data is reloaded into the viewing session, the user will notice that, in the Trial Variable Value Editor dialog, each column lists the values extract from the data file for a trial condition variable whereas the first row of the dialog box reads as "File, Trial, Variable 0, Variable 1, …". To assign more meaningful labels for the trial variables, start the Trial Variable Manager dialog, select the variables and edit their labels while keeping the default values unchanged (see Figure 8-8).

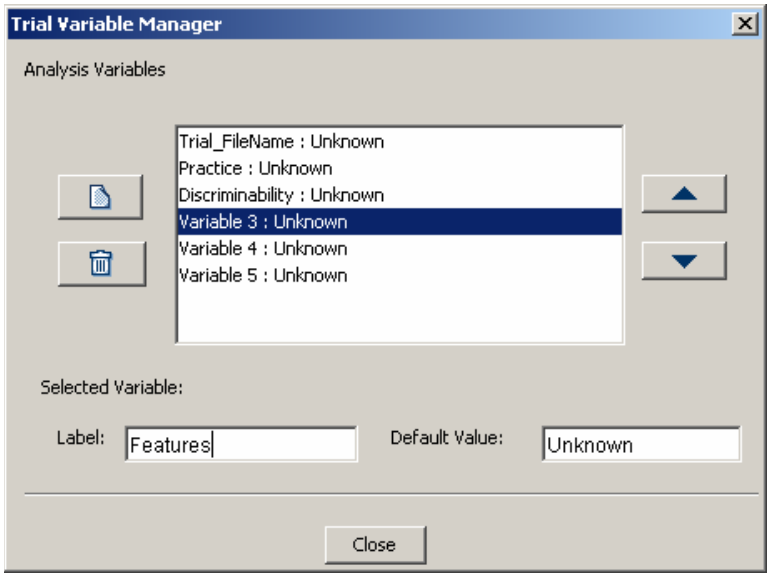


Figure 8-8. Using the Trial Variable Manager: Changing Variable Labels

8.3.3 Managing Reaction-time definitions

One of the important features of the EyeLink Data Viewer is the capability of creating condition-based or trial-based reaction-time definitions. For example, for the current example, we may want to calculate reaction times for target-absent trials (terminated by pressing button 3) and target-present trials (terminated by pressing button 4) separately. Such functionality can be achieved in several ways. In the first approach, simple messages can be added in the EDF file to automate a set of condition-based reaction-time definitions (see section 7.4.1). The C code to record such messages could be

```
eyemsg_printf("V_RT BUTTON SYNCTIME 3 1 PRESENCE Absent");
eyemsg_printf("V_RT BUTTON SYNCTIME 4 1 PRESENCE Present");
```

To enable the correct loading of these condition-based reaction time definitions, the above messages must be sent to the EDF file prior to the first trial start message (e.g., TRIALID) but adter the TRIAL_VAR_LABEL message.

Alternatively, a trial-specific RT message can be recorded for each individual trial. Thus, for all target-absent trials, a message like `eyemsg_printf("!V V_CRT BUTTON SYNCTIME 3 1")` can be added to the experiment source code whereas for all target-present trials, a message like `eyemsg_printf("!V V_CRT BUTTON SYNCTIME 4 1")` can be added. To enable the proper functioning of the trial-based reaction time definitions, the above messages must be recorded within the scope of trial as defined for the Viewer (see section 7.1).

A third approach, as illustrated in the current tutorial, is to create a set of condition-based reaction time definitions manually (see section 6.3). To manually create new RT definitions or to review\edit existing RT definitions, click Analysis → Reaction Time manager from the application menu (see Figure 8-9). In the following reaction time

manager dialog, click on the "New RT Definition" button ( ). In the Reaction Time Definition Editor dialog (General Tab), enter the label *RT_Absent*. In the trial condition qualifiers list, select the variable "PRESENCE" and type in *Absent* (case-sensitive, without quotation marks) in the value edit box and press the Enter key. Since participants pressed a specific button to end a trial, keep the default "Button Event" as the reaction time end event.

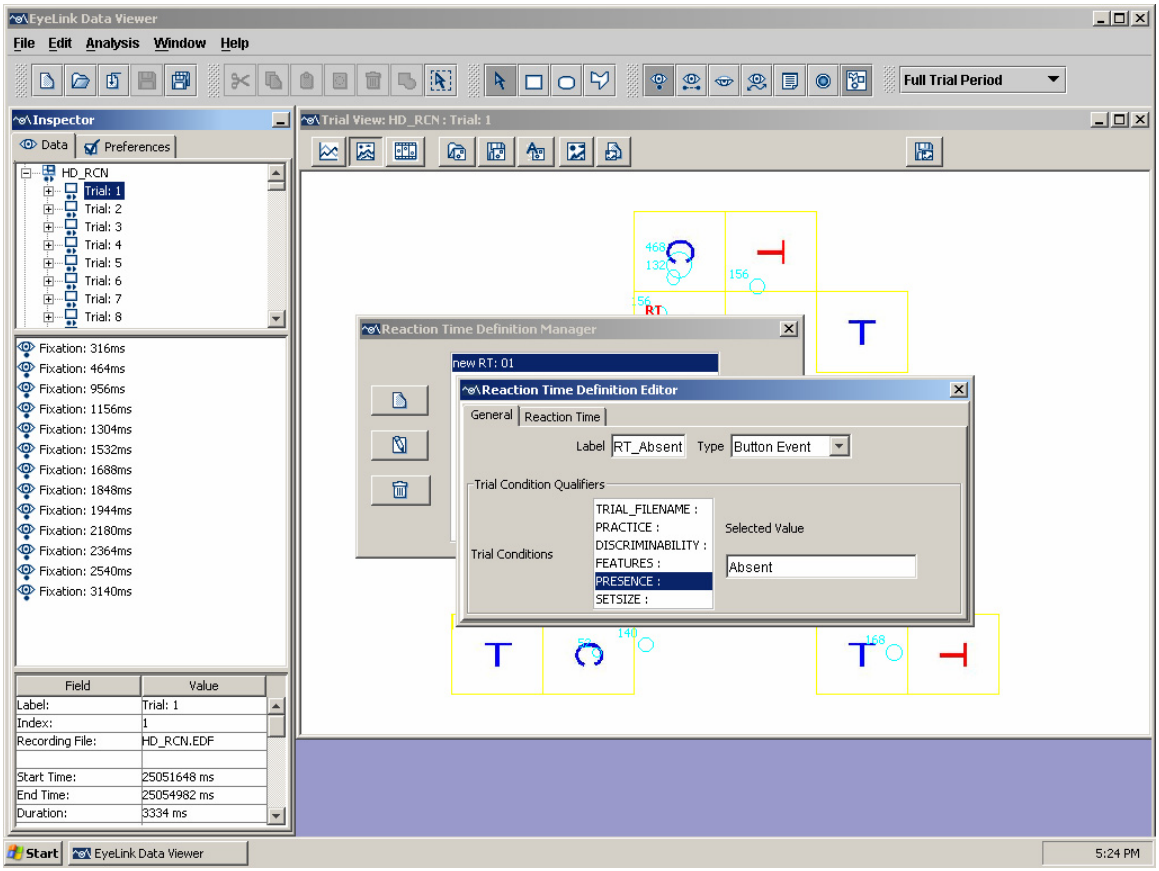


Figure 8-9. Creating/Editing Reaction Time Definition (General Tab)

Click the Reaction Time Tab (see Figure 8-10). Because the start event of reaction time calculation is the onset of the search display, keep the start time message text as "SYNCTIME". From the button number combo box, select button 3 (this number depends on the actual button designated as the response button) and set the button state as "Pressed".

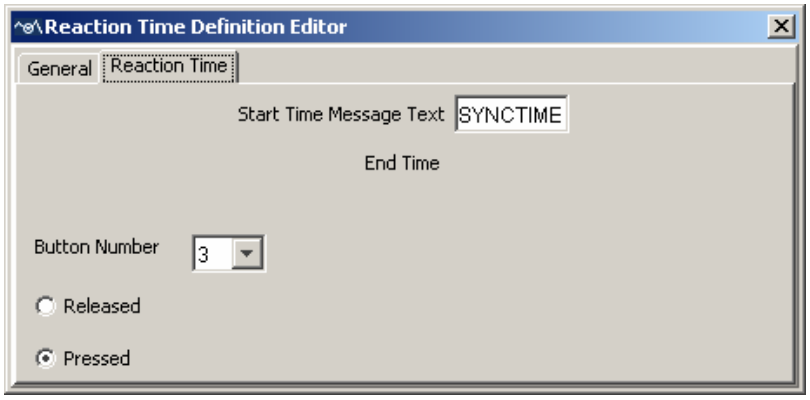


Figure 8-10. Creating/Editing Reaction Time Definition (Reaction Time Tab)

Once this has been done, close the Reaction Time Definition Editor dialog. From the Reaction Time Definition Manager dialog, repeat the process of RT definition for target-present trials (Label: "RT_Present"; Type: Button Event; Trial Condition Variable "PRESENCE": Present; Start Time Message Text: "SYNCTIME"; Button Number: 4; Button State: selected). A selected RT definition can be edited by clicking on button and removed by clicking the button. Once all of the RT definitions have been finalized, close the Reaction Time Definition Manager dialog. In the following "Initialize All RT Events" dialog, click the "Yes" button to apply the RT definitions.

For each trial if a matching reaction time definition is found, a red RT symbol is displayed near the end event in the spatial overlay view of the trial view window. In the temporal graph view, a green line is drawn at the time when the start message is recorded and a red line is drawn at the time when the end event occurred. In the event list of the Inspector window, the RT End Event field is automatically checked for the end event that matches the reaction time definition.

8.3.4 Manipulating Events

The EyeLink Data Viewer supports several forms of event manipulation, including hiding, deleting, merging, and drift correction. The current tutorial focused on hiding events, merging and drift correcting fixations (see Section 5 "Working with Events, samples, and Interest Areas" for detailed documentation of all event manipulations).

8.3.4.1 Hiding Events

Within each trial, some events may be hidden from analysis so that the user can focus on a subset of data in each trial. Event hiding can be done either manually (see section 5.1.2) or through the definition of some data filters. For example, the user may be interested in the fixations and saccades within the reaction-time definition of a trial only (i.e., between the onset of the search display and the press of the response button). As a result, those events prior to and following the RT definitions may be hidden from viewing and analysis output. This can be achieved by applying a set of data filter in the preference

settings. In the Inspector Window, click the Preferences Tab and select the Data Filters node. For the current example, check the "Hide Events outside RT definition" and "Hide Spanned Events" check boxes. If only fixations, saccades, and blinks are to be hidden, check the "Hide Eye Events Only" (otherwise, all events falling outside the filter will be hidden).

Note: By default, if an event is hidden, it will be removed from the temporal graph view, spatial overlay view, as well as the output report. However, if the field of "Include Hidden Events" in the General Preference Settings (see section 9.1) is checked, hidden events can also be shown in the trial view windows. Those events will be drawn in dashed lines.

8.3.4.2 Merging and Drift-correcting Fixations

Temporally contiguous fixations can be merged (see section 5.2.2). For example, for the second trial of the current example, the user may decide to merge the last two fixations on the search target (see Figure 8-11). This can be done by selecting the two fixations (click on the first fixation, press the CTRL key and then click on the second fixation), clicking the right mouse button and selecting the "Merge" operation. Once such an operation is performed, information on fixations is updated in both the Inspector window and the trial-view window.

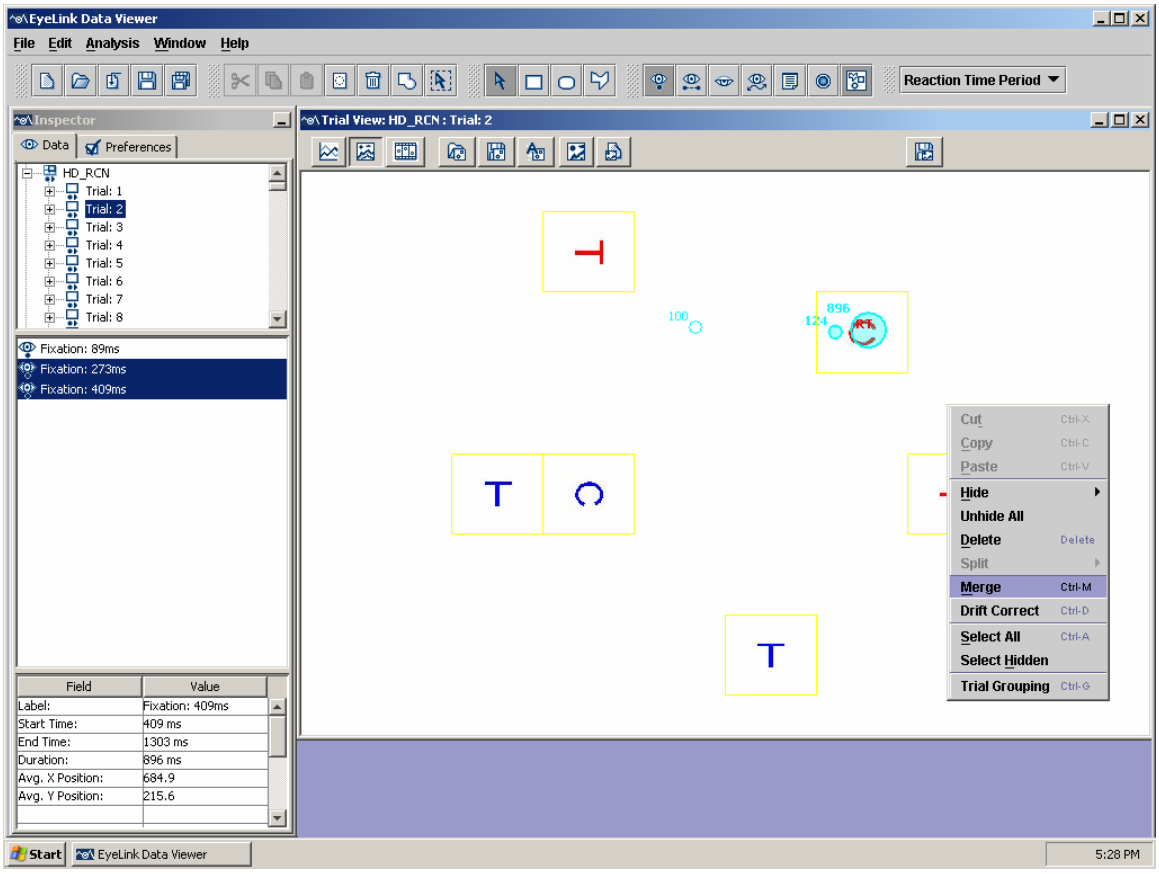


Figure 8-11. Merging Fixations

Drift correcting fixations can also be performed. This is only suggested if it is obvious to the user that improper system setup or calibration has resulted in a trial's fixation data containing significant drift that can be easily corrected manually. To illustrate the usage of this functionality, for any trial, select the set of fixations to be adjusted, press the Alt key, and then use the cursor keys to move the selected fixations to the desired locations (see section 5.2.3 Drift Correcting Fixations for more information).

8.3.5 Analysis Output

In a typical viewing session, the final step is to extract useful eye-movement information and export the data to statistical software. The EyeLink Data Viewer supports the output of several types of analysis reports (see chapter 6 "Exporting Data"). The current tutorial focuses mainly on two of them, namely, the trial output report and the fixation output report.

8.3.5.1 Trial output report

The trial output report provides a summary of some important measures for individual trials (see section 6.5.2 for a complete list of the variables). The user may be interested in only a subset of the variables provided by the Viewer. For the current example, we record trial condition values, response time, number of fixations, as well as information on number of saccades, average fixation duration, and average saccadic amplitude in a given trial.

To obtain a trial output report, select Analysis → Report → Trial Report from the application menu. Select all of the desired variables and enter them to the list of selected output variables (see Figure 8-12). Click the "Next" button and in the Filename edit box, enter the desired file name with an appropriate extension (the common file extensions that the Viewer supports are .txt or .xls).

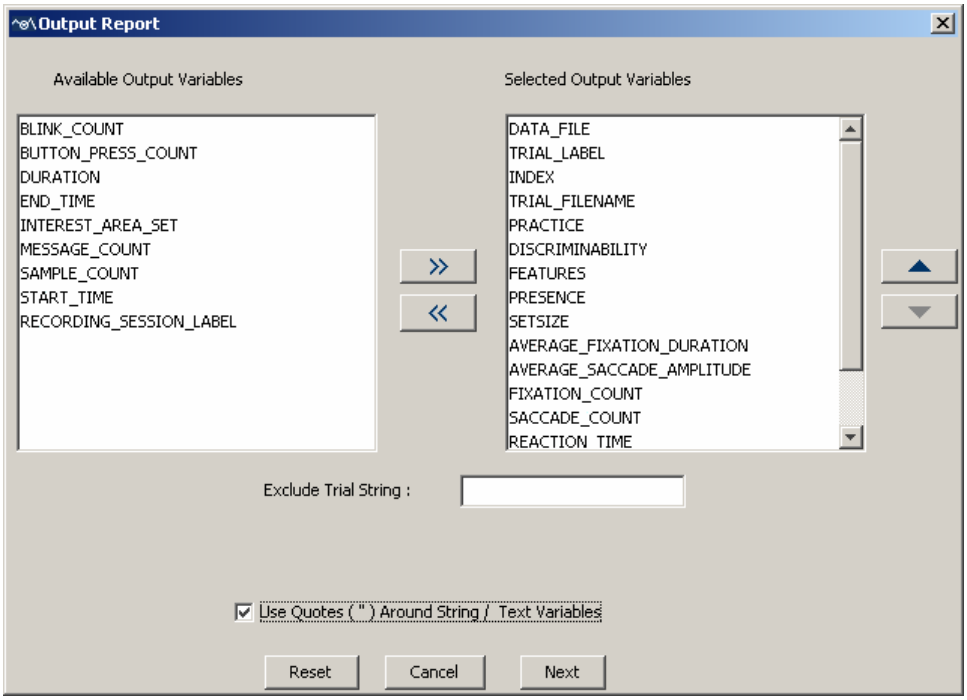


Figure 8-12. Obtaining a Trial Output Report

Once a trial output file is obtained, the data can be imported into a statistical package and analyses can be performed on the variables in question (RT and number of fixations in the current example). Note that for some statistical software, the user may have to modify the default variable labels so that the data can be successfully loaded. Also note that Tab is the delimiter used by the Viewer to separate neighboring variables. For some statistical packages, it may be desirable to check "Use Quotes around String/Text Variables" to make sure that any space within a string will not be treated as a delimiter. The following graphs show the results for reaction time and the number of fixations per trial in each search condition following the removal of practice trials and those trials with no matching reaction-time definitions.

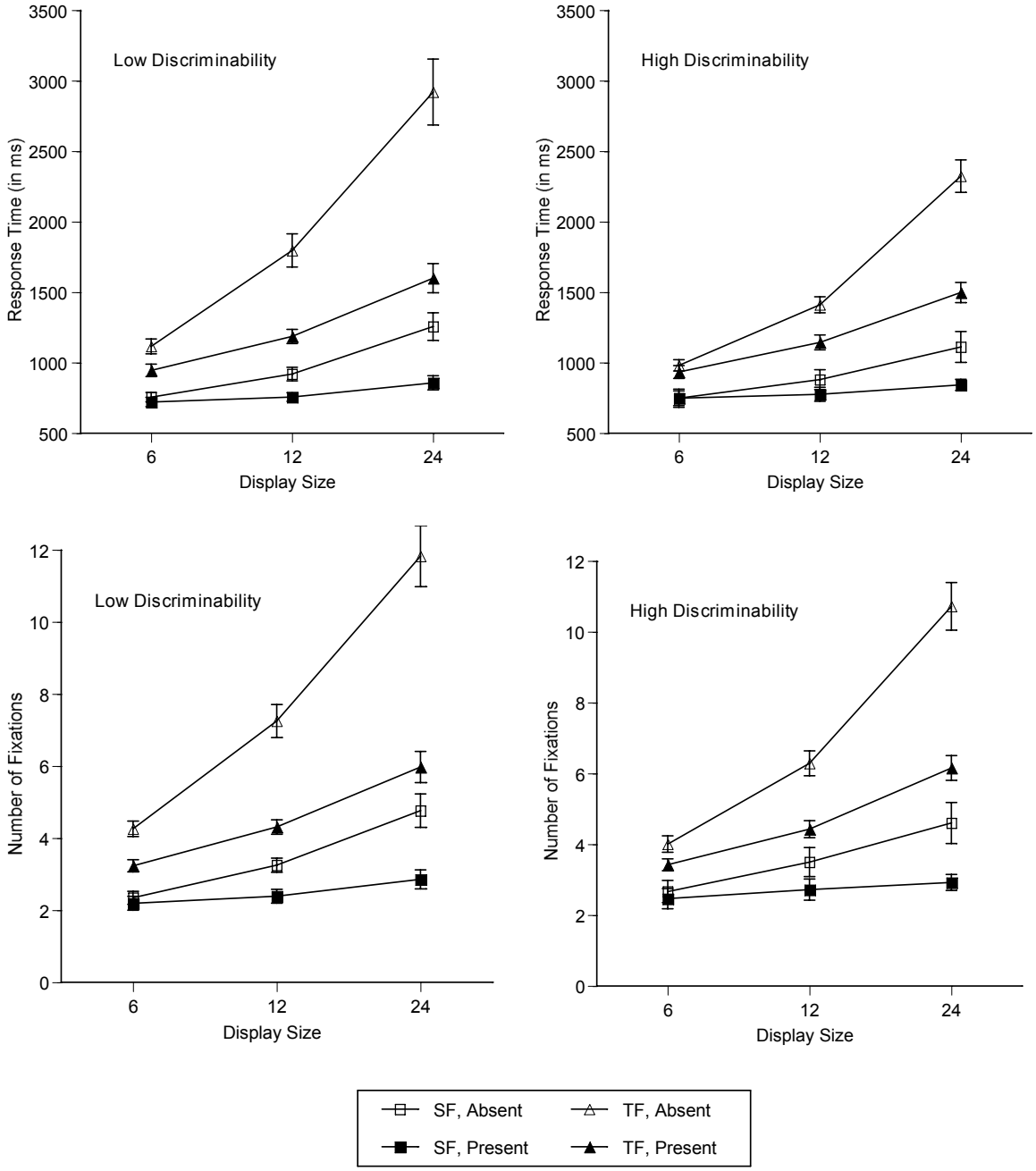


Figure 8-13. Response Time (in msec) and Number of Fixations per Trial as a function target-presence and display size in both the single-feature (SF) and two-feature (TF) search tasks in the high-discriminability (N = 8) and the low-discriminability conditions (N = 8).

8.3.5.2 Fixation output report

Similarly, a fixation output report can be obtained. The fixation output report generates one row for each visible fixation within the Viewer, including several variables

describing the current fixation, as well as a set of relative variables describing the previous and next fixations and saccades (see section 6.6.2 for a complete list of variables in the fixation report). For the current example, since we are interested in whether the distribution of fixations differed across different types of display items, we need to select variables such as fixation index, the closest interest area to which the current fixation is assigned and the label of that interest area. In addition, we also planned to examine whether such a distribution is influenced by the amplitude of the previous saccade (PREVIOUS_SAC_AMPLITUDE) and whether, for the first fixations, the distribution was influenced by the initial saccadic latency of the trial (in the current example, the initial saccadic latency of the trial can be calculated as the PREVIOUS_SAC_START_TIME for the first valid fixation in the trial).

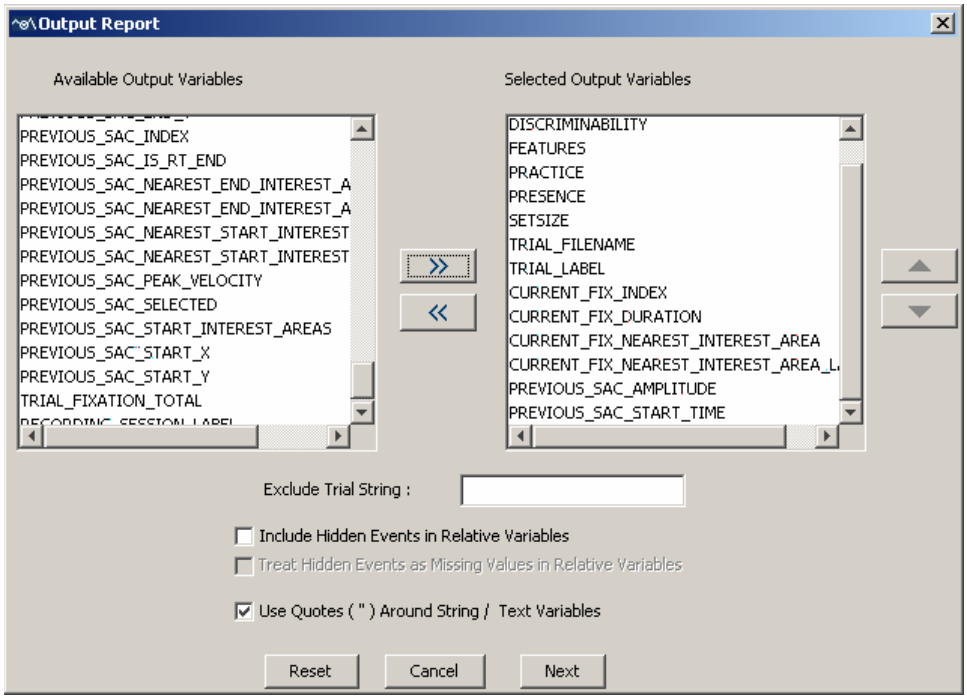


Figure 8-14. Obtaining a Fixation Output Report.

To obtain a fixation output report, select Analysis → Report → Fixation Report from the application menu. Select all of the desired variables and enter them to the list of selected output variables (see Figure 8-14). Click the "Next" button and in the Filename edit box, enter the desired file name with an appropriate extension (.xls or .txt). The following Figure 8-15, Tables 1 and 2 present the analysis output for the distribution of fixations as a function of distractor type.

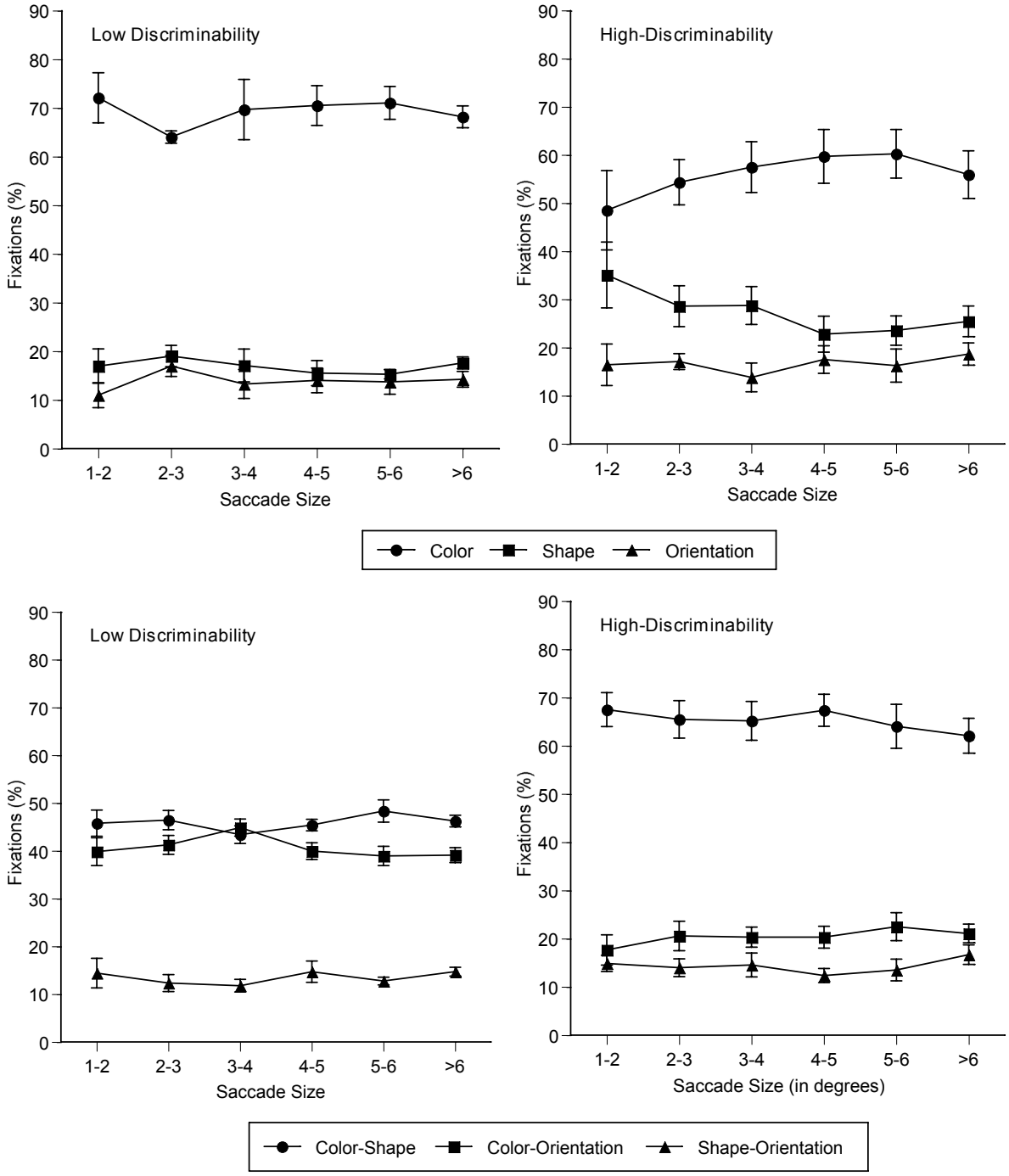


Figure 8-15. Average proportion of fixations assigned to distractors sharing target color, shape, orientation in the single-feature search task (top panels) and to distractors sharing target color shape, color orientation, or shape orientation in the two-feature search task (bottom panels) as a function of saccade amplitude. Note that results for saccades smaller than 1º are not reported because of insufficient data points in some cells.

Table 1. Average percent of fixations by discriminability and search task for the first fixations following a short (below median) and long (above median) initial saccadic latency.

			Short Latency		Long Latency	
Condition	Task		%	SEM	%	SEM
LD	SF	C	64.504	3.728	70.765	3.619
(N=8)		S	19.378	1.705	15.419	2.587
		O	16.119	2.715	13.816	2.665
	TF	CS	34.059	2.362	45.268	3.849
		CO	41.993	1.797	40.349	2.145
		SO	23.948	2.849	14.383	2.186
HD	SF	C	50.863	6.898	55.972	6.167
(N=8)		S	27.082	3.290	26.924	4.935
		O	22.055	4.678	17.104	1.976
	TF	CS	39.978	2.569	54.176	5.044
		CO	33.914	1.825	29.265	3.852
		SO	26.109	3.187	16.558	2.434

Table 2. Average percent of fixations by discriminability and search task for the first fixations, second fixations, and all fixations.

			First Fixations		Second Fixations		All Fixations	
Condition	Task		%	SEM	%	SEM	%	SEM
LD	SF	C	67.467	3.204	70.893	2.692	68.307	2.416
(N=8)		S	17.761	2.008	16.377	1.641	17.527	1.256
		O	14.772	2.216	12.729	1.765	14.166	1.378
	TF	CS	39.742	2.299	54.386	3.792	45.840	0.934
		CO	40.948	1.135	35.393	3.240	40.088	1.146
		SO	19.309	2.146	10.222	1.614	14.073	1.058
HD	SF	C	53.446	6.096	56.509	4.394	56.209	4.789
(N=8)		S	27.060	3.668	29.872	3.564	26.342	3.245
		O	19.493	3.104	13.619	1.804	17.449	2.007
	TF	CS	47.103	3.555	79.496	3.296	63.855	3.515
		CO	31.606	2.141	13.146	2.378	20.733	20.64
		SO	21.290	2.476	7.357	1.324	15.412	1.694

Note — C, color; S, shape; O, orientation; CS, color shape; CO, color orientation; SO, shape orientation; LD, low-discriminability condition; HD, high discriminability condition; SF, single-feature search task; TF, two-feature search task.

8.4 Reference

Williams, D. E., & Reingold, E. M. (2001). Preattentive guidance of eye movements during triple conjunction search tasks: The effects of feature discriminability and saccadic amplitude. *Psychonomic Bulletin & Review*, *8*, 476-488.

9 Preference Settings

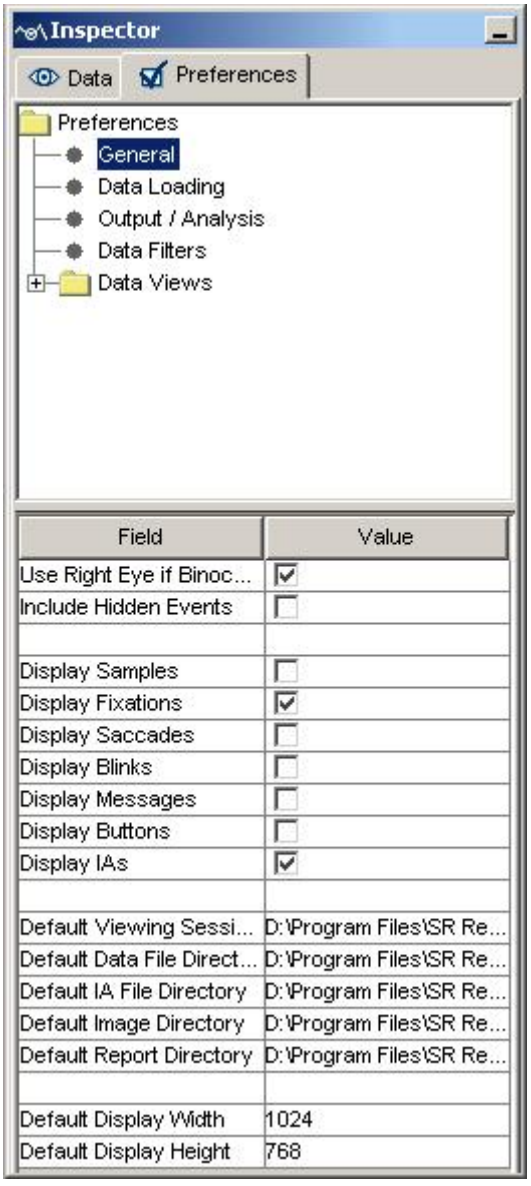
All the elements of the EyeLink Data Viewer can be configured by the user from the Preference tab of the Inspector Window. These include everything from the default colors used, to the elements of how an EDF file is loaded. All the changes can be saved, allowing the changed preference settings to be loaded in subsequent viewing sessions.

Any preferences setting can be edited by clicking on the value cell and changing the value. For string and number values, be sure to press Enter after making the change to register your input with the application.

Tip*:* The changed preference settings can be saved by clicking the right mouse buttons and clicking on “Save Properties as Defaults”.

9.1 General Preferences

The general preference setting covers the following elements:



Use Right Eye if Binocular: For a binocular recording, which eye's data is to be displayed (right eye if checked; left eye if unchecked);

Include Hidden Events: Whether or not to include hidden events in Trial Views and Output Reports;

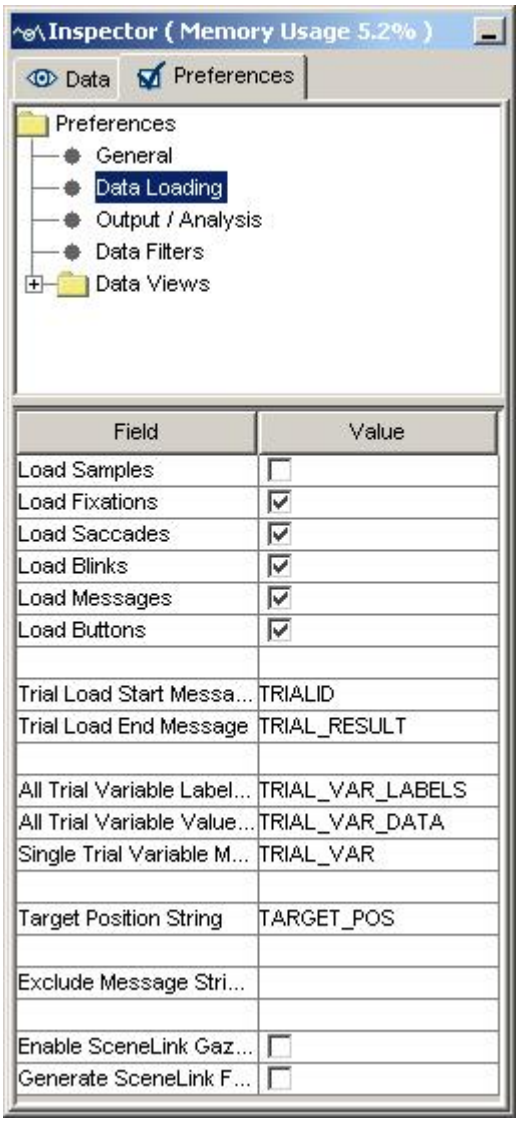
Display Samples, Display Fixations, Display Saccades, Display Blinks, Display Messages, Display Buttons, and **Display IAs:** Whether or not to display samples, fixations, saccades, blinks, messages, buttons, and interest areas when the data file is first loaded (by default, only fixations and interest areas are displayed);

Default Viewing Session File Directory, Default Data File Directory, Default IA File Directory, Default Image Directory, and Default Report Directory: Set default directories for accessing viewing session files, data file loading, interest area, images loading/saving, and data output. These settings can be changed by clicking on the current values and choosing a default directory from a Set window. Note, changes to these preference settings only take effect on files loaded after the change.

Default Display Width and **Default Display Height**: Set display width and height to enable the Data Viewer to run properly if DISPLAY_COORDS/GAZE_COORDS message is not found in the EDF file; otherwise, these preferences are ignored;

9.2 Data Loading Preferences

Data loading preference settings consist of the following parameters:



Load Samples, Load Fixations, Load Saccades, Load Blinks, **Load Messages, Load Buttons:** Allow the loading of samples, fixations, saccades, blinks, messages, and buttons from the EDF files. By default all of the events are loaded whereas samples are not. ***Note:*** Versions before 1.7.1 loads samples as well by default.

Trial Load Start Message and **Trial Load End Message**: Define the start and end messages of data loading. For each trial, all events/samples before the start message or after the end message will not be loaded. By default, the Viewer treats the "TRIALID" as the start message for data loading and "TRIAL_RESULT" as the end message. (Note: the **Trial Load Start Message** must be one message before START recording, otherwise the Viewer will internally re-set the loading position at the start of trial recording to keep trial data integrity.)

All Trial Variable Labels Message and **All Trial Variable Values Message**: The former allows the definition of labels to be used for trial variables within the viewer and the latter specifies the list of trial variable values for the trial. By default, the trial variable labels message is set as "TRIAL_VAR_LABELS" and the trial variable values message is set as "TRIAL_VAR_DATA".

Single Trial Variable Message: This command lets the user specify a trial variable and value for the given trial. Send one message for each pair of trial condition variable

and its corresponding value. This means that there is really no need to use TRIAL_VAR_LABELS command when using TRIAL_VAR command. Default command token is "TRIAL_VAR".

Target Position String: String used to specify the position of the targets at the specific message time.

Exclude Message String: Any messages (within the scope of a trial as defined by the Trial Load Start Message and Trial Load End Message) containing the string will be ignored by the Viewer. Add a ";" to separate multiple message strings.

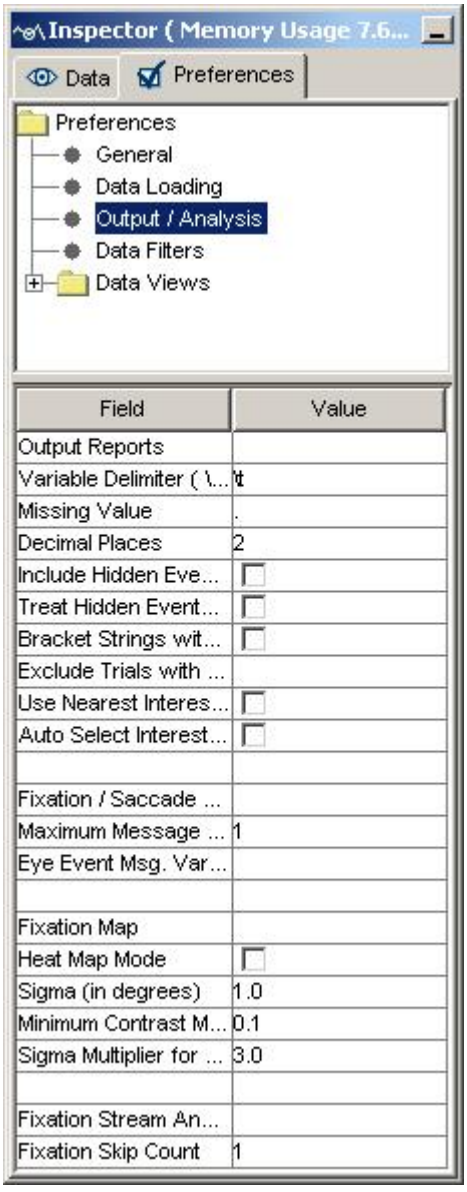
Enable SceneLink Gaze Mapping: If checked, allows the user to load EDF file with mapped gaze data to scene video coordinates.

Generate SceneLink Frame Message: If checked, allows the user to generate frame number messages when loading file. The frame number message will only be written if a lookup table has been created for synchronized playback of eye movement data over the scene video (see section 5.1 of the "EyeLink II Scene Camera User Manual").

Note: The user has to save the preferences and reload the data file before the changes in the above preference settings take effect.

9.3 Output / Analysis

The output / analysis preference settings consist of the following elements:



Output Reports

Variable Delimiter (\t for Tab): Specifies the delimiter string for separating columns in the output file.

Missing Value: Replaces variables with missing value with a string specified here.

Decimal Places: Specifies the number of digits to appear after the decimal point.

Include Hidden Events in Relative Variables: Allows the inclusion of hidden events in the relative event variables [i.e., those variables beginning with PREVIOUS_FIX_, NEXT_FIX_, PREVIOUS_SAC_, or NEXT_SAC_].

Treat Hidden Events as Missing Values: If hidden events in the relative variables are included in the analysis, the user can further decide whether or not to treat these events as missing data.

Bracket Strings with Quotes: Adds a pair of quotation marks for string variables.

Exclude Trials with Message String: Excludes trials containing the specified message string. This string should be one message or part of a message within the scope of a trial that uniquely defines that subset of trials to be excluded.

Auto Select IAS for Trial: If true, trial interest area set association is done automatically by using "Image Name mapping" attribute of interest area set templates in the Data Viewer session (see section 5.8.8 “Automatic Trial Image-Interest Area Set

Association" for details). The default is false.

Use Nearest Interest Area for Outlier Fixations: If the current fixation is not in any defined interest areas, assigns the nearest interest area as the current interest area.

Fixation/Saccade Report

Maximum Message Variables for Eye Event: Maximum number of messages associated with a given fixation or saccade that will be shown in the output report.

Eye Event Msg. Variable String Match Token: If left blank, all messages associated with an eye event will be reported; otherwise, only those messages containing the "token" will be reported.

Fixation Map

Heat Map Mode: If enabled, the fixation map will be drawn in colored heat map; if unchecked, a grayscaled version will be created.

Sigma (in degrees): Sets standard deviation of the Gaussian distribution for each fixation point when creating a Fixation map.

Minimum Contrast Multiplier (0.0- 1.0): Sets the contrast between the fixation hotspots and the background (0: with maximum contrast and 1: with minimum contrast).

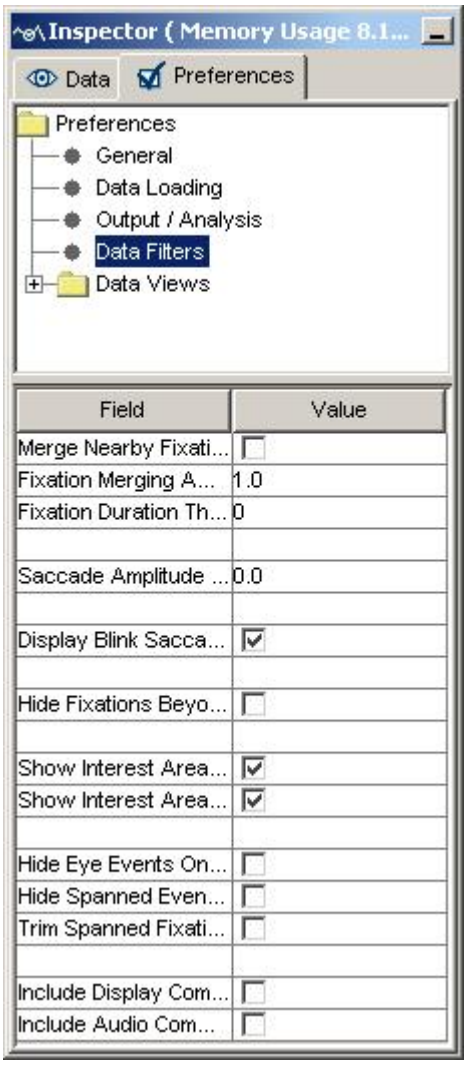
Sigma Multiplier for Update Range: Number of standard deviations extended for each fixation point when creating the Fixation map. For most users, keep this setting unchanged.

Fixation Stream Analysis

Fixation Skip Count: Defines the number of fixations to skip when looking for the next interest area to use in the fixation sequence analysis variables of the Interest Area report. Default is 1. Can not be less than 1.

9.4 Data Filter Preferences

The data filter preference settings consist of the following elements:



Merge Nearby Fixations: If checked, merge the neighboring brief fixations. A fixation to be merged must have a duration of less than that specified by Fixation Duration Threshold and be within 1° of the target fixation. These default thresholds are set in the "Amplitude Threshold" and "Fixation Duration Threshold" fields.

Fixation Merging Amplitude Threshold: Sets the amplitude threshold for fixation merging. The default value is 1.0º.

Fixation Duration Threshold: Sets the fixation duration threshold for fixation merging. A fixation will be merged if "Merge Nearby Fixations" is on and its duration is less than the specified duration threshold.

Saccade Amplitude Threshold: Sets the minimum size of a saccade to be displayed in the viewing session. All saccades will be displayed with an amplitude threshold set to 0.0.

Display Blink Saccades: Shows flanking saccades of a blink.

Hide Fixations Beyond Display Bounds: Whether or not to hide the fixations falling beyond the display boundaries;

Show Interest Areas Pre Interest Period: If interest periods are defined, whether or not to display interest area timed before the start of a selected interest period. If no interest periods are defined, the interest areas are displayed anyway.

Show Interest Areas Post Interest Period: If interest periods are defined, whether or

not to display interest area timed after the end of a selected interest period. If no interest periods are defined, the interest areas are displayed anyway.

Hide Eye Events Only: If checked, filters out eye events (fixations, saccades, and blinks) falling outside of the RT definition. If unchecked, filter out all events, including buttons events and messages.

Hide Spanned Events: For the RT filter, whether or not to hide an event (e.g., fixation or saccade) that overlaps with the start event or end event of the RT definition.

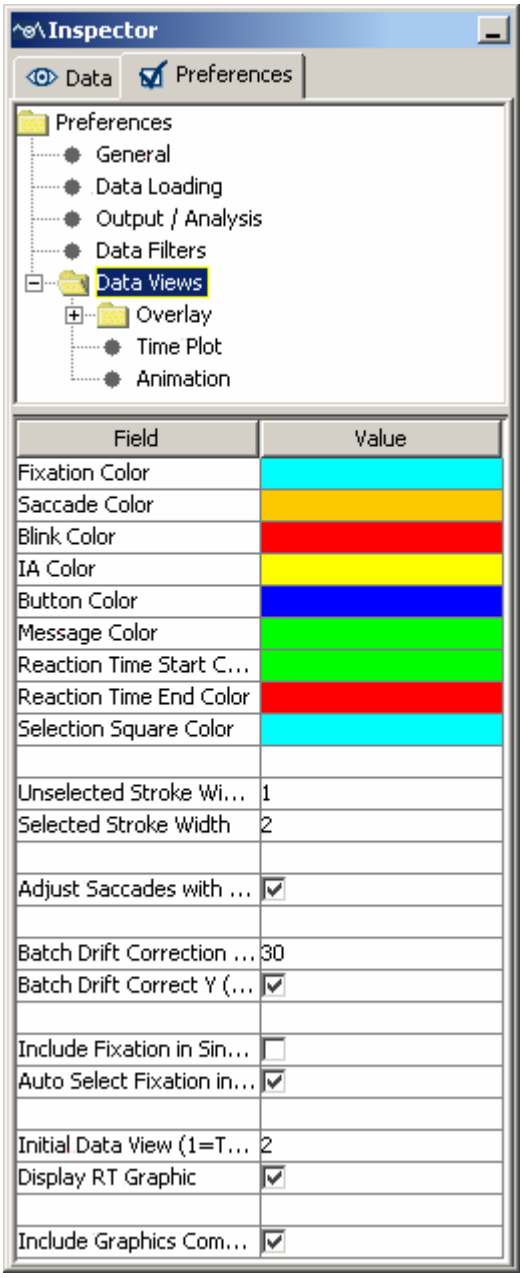
Trimmed Spanned Fixation Duration: If an interest period/reaction time filter is applied, the duration of the fixation that overlaps the start or end of the interest period will be trimmed so that only the portion of fixation within the interest period will be reported.

Include Display Command Messages: Whether display command messages (i.e., command message starts with "!V" listed in sections 7.3.2 image loading and 7.3.3 simple graphics) should be visible.

Include Audio Command Messages: Whether audio command messages should be visible. The following built in audio messages are supported: "!V ARECSTART", "!V ARECSTOP", "!V VOICEKEY", "!V APLAYSTART", and "!V APLAYSTOP".

9.5 General Trial View Preferences

The parameters related to the general trial view preference settings are covered below:



Fixation Color, Saccade Color, Blink Color, IA color, Button Color, Message Color, Reaction Time Start Color, Reaction Time End Color, and **Selection Square Color**: Set the colors to be used to show fixations, saccades, blinks, interest areas, button events, messages, the start/end of reaction time calculation, and the event selection square. These settings can be changed by clicking the corresponding cell and choosing a color from the palette dialog or entering the value in RGB or HSB scales.

Unselected Stroke Width and **Selected Stroke Width**: Pixel width for the selected and unselected events;

Adjust Saccades with Fixations: Whether or not to adjust saccade parameters when the fixations are shifted or merged;

Batch Drift Correction Error Threshold: The maximum tolerable deviation in the Y dimension (or the X dimension if the next field is unchecked) for a fixation from the mean of the group of fixations to be drift-corrected in a batch. If any fixations within the group exceeds this threshold, batch drift correction cannot be performed.

Batch Drift Correction Y (X=false): If checked, chooses the Y dimension for batch drift correction. If unchecked, X dimension is checked;

Include Fixation in Single IA: In case of overlapping interest areas, whether or not to limit the assignment of a fixation to one interest area (the interest area with a smaller

ID) only;

Auto Select Fixation in Selected IA: When an interest area is selected, whether or not to select fixations inside the IA as well;

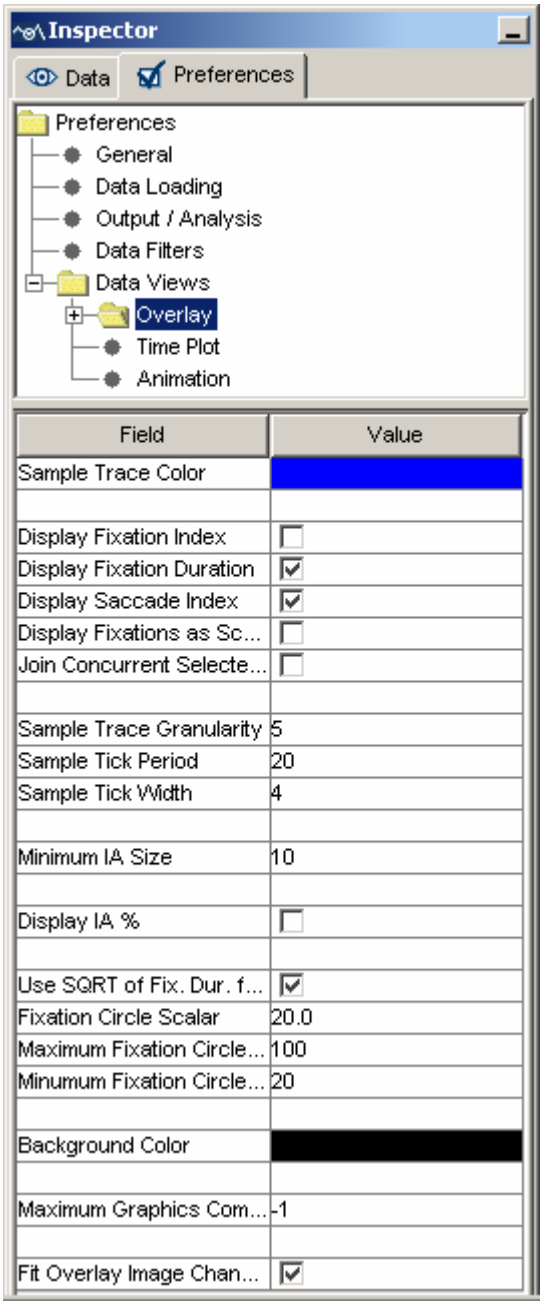
Initial Data View (1 = TP; 2 = OL; 3 = AV): Selects the mode (1= temporal graph mode; 2 = spatial overlay mode; 3 = animation playback mode) of the trial view window when the data is first loaded;

Display RT Graphics: If reaction time definitions are initialized, whether or not to show the "RT" symbol in the spatial overlay view and to draw the Reaction Time Start/End lines in the temporal graph view of the trial data.

Include Graphics Commands Sent Prior to IP: If no graphics commands are found within the current interest period, uses those sent prior to the current interest period.

9.6 Spatial Overlay View Preferences

The spatial overlay view preference settings cover the following parameters:



Sample Trace Color: Sets the color to be used to show the sample trace;

Display Fixation Index, Display Fixation Duration, and **Display Saccade Index**: Whether or not to show the fixation index/fixation duration/saccade index in the spatial overlay view;

Display Fixations as Scan Path: If checked, two temporally contiguous fixations are connected by an arrow, pointing towards the more recent fixation;

Joint Concurrent Selected Fixations: For the selected fixations, connects temporally contiguous fixations;

Sample Trace Granularity: If the sample visibility is toggled on, shows every *n*th sample (by default, n = 5);

Sample Tick Period: Draws a circular tick for every *n*th sample (by default, n = 20). Widely spread ticks indicate high saccade velocity;

Sample Tick Width: Diameter (in pixels) of the sample ticks;

Minimum IA Size: Minimum width of an interest area;

Display IA%: If selected, shows percentage of trial dwell time spent on the selected interest area

Use SQRT of Fixation Duration for Circle Size: Uses the square root of fixation duration to calculate the width of the fixation circle if checked.

Fixation Circle Scalar, Maximum Fixation Circle Width, and **Minimum Fixation Circle Width**: If the above **Use SQRT of Fixation Duration for Circle Size** option is not used, use **Fixation Circle Scalar** to define a scalar for fixation circle width calculation. The maximum and minimum circle widths are set with the **Maximum Fixation Circle Width/Minimum Fixation Circle Width** elements;

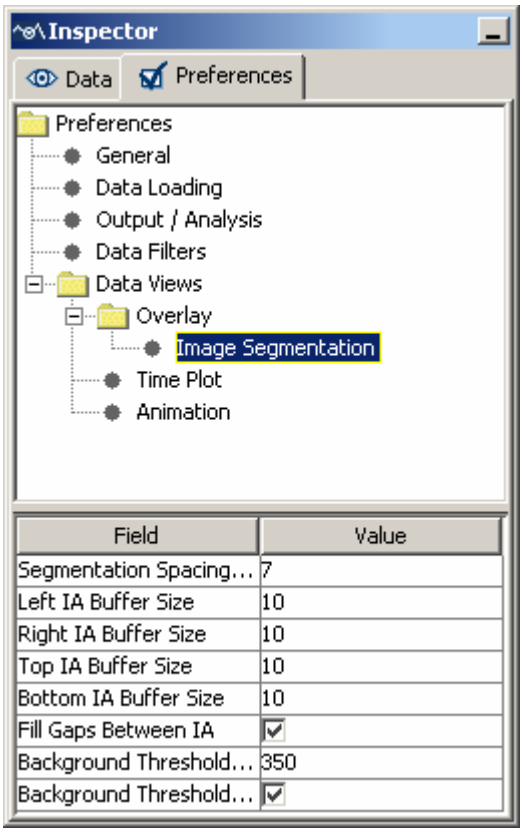
Background Color: Background color for the spatial overlay view (used only if the trial bitmap is not loaded).

Maximum Graphics Commands to Process: Sets the maximum number of graphics commands to process in each trial. This command is useful for those trials in which there are many viewer graphics commands while the user may just need to see a few of them. If it is set to -1, the viewer will process all graphics commands. For all other entries of integer numbers, the viewer will process the number of graphics commands specified when creating background image for overlay view.

Fit Overlay Image Change to Display: If True, when the background image for a trial is manually changed, the image is scaled to fit the display dimensions for the trial. If false, the image size is not altered and the image is centered on the trial overlay view.

9.7 Image Segmentation Preferences

The parameters related to the auto image segmentation preference settings are covered below:



Segmentation Spacing Threshold: Number of consecutive pixels below threshold before segment end is identified.

Left IA Buffer Size, **Right IA Buffer Size**, **Top IA Buffer Size**, **Bottom IA Buffer Size**: Number of pixels added to the left, top, right, and bottom of the interest area. Note that the **Top IA Buffer Size**, **Bottom IA Buffer Size** fields will not have an effect if **Fill Gaps Between IA** is checked.

Fill Gaps Between IA: If checked, gaps between consecutive Interest Areas will be filled by expanding the size of each Interest Area.

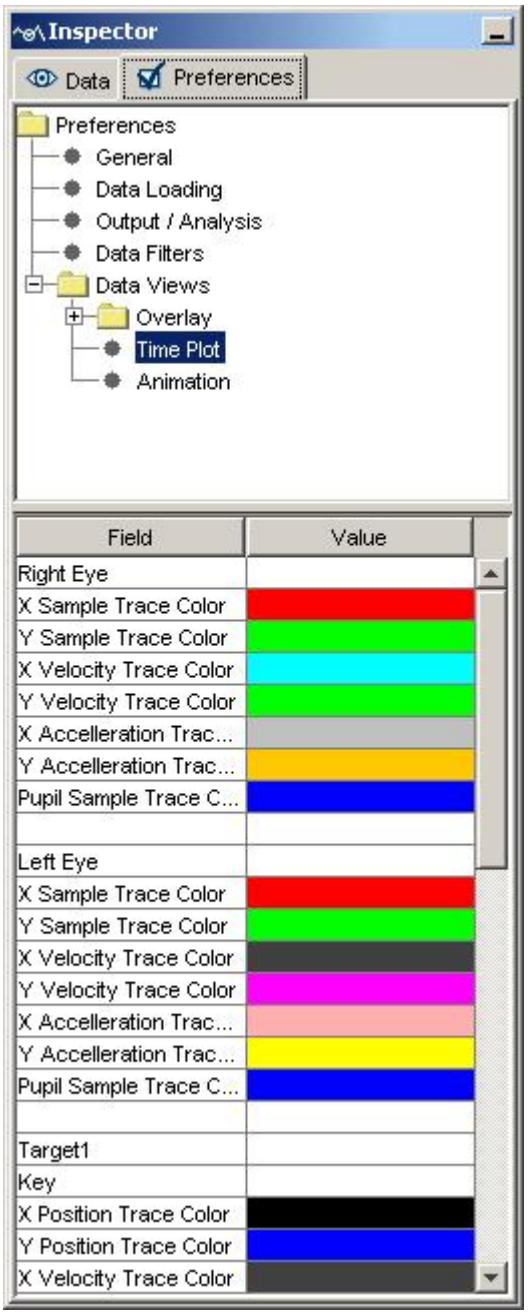
Background Threshold (0-765): Combined RGB (R+G+B) to be used as the threshold limit for segmentation.

Background Threshold Less Than: If checked, pixels with a RGB value less than the threshold color are considered 'background' pixels. This setting is good for displays with a lighter background. If this field is unchecked, pixels with an RGB value greater than the threshold are considered background pixels (good for displays with a darker background).

Note: Auto segmentation may not work for a display with vertical stripes along its border(s) that have the 'foreground' color. If such stripes are not part of the original image, try to reload the background image or to change the background color for the spatial overlay view to match with the background color of the original image.

9.8 Temporal Graph Preferences

The parameters related to the temporal graph view preference settings are covered below:



Left Eye/Right Eye

X Sample Trace Color, Y Sample Trace Color, X Velocity Trace Color, Y Velocity Trace Color, X Acceleration Trace Color, Y Acceleration Trace Color, and Pupil Sample Trace Color: Set the colors to be used to show the horizontal and vertical position, velocity, and acceleration traces of the eye samples. The pupil sample traces of both eyes are also displayed. The default settings can be changed by clicking the corresponding cell and choosing a color from the palette or entering the value in RGB or HSB scales;

Target 1/Target 2

Key: Token word to indicate the target ID. This field is set to blank by default so that various token words can be used. If two targets are involved and if the order of the two targets is important, set this field to the token string used in the EDF file.

X Position Trace Color, Y Position Trace Color, X Velocity Trace Color, Y Velocity Trace Color, X Acceleration Trace Color, Y Acceleration Trace Color, and Pupil Sample Trace Color: Set the colors to be used to show the horizontal and vertical position, velocity, and acceleration traces of the targets. The default settings can be changed by clicking the corresponding cell and choosing a color from the palette or entering the value in RGB or HSB scales;

Acceleration Trace Scaling Factor and **Velocity Trace Scaling Factor**: Set the scaling factor for the acceleration and velocity data so that these two traces can be displayed appropriately in this view;

Message Triangle Width, Message Triangle Height, Button Triangle Width, and **Button Triangle Height**: Set the width and height of the symbols for message and button events;

Background Color and **Ruler color**: Set the colors for background and ruler of the temporal graph view.

Split Y axis: If true, 0 appear in the middle of the screen, positive values on the top and negative values at the bottom; otherwise, a descending scale is used, with large values on the Y-axis appearing at the bottom of the screen. Note, this setting will only be effective when the data are loaded in a new viewing session.

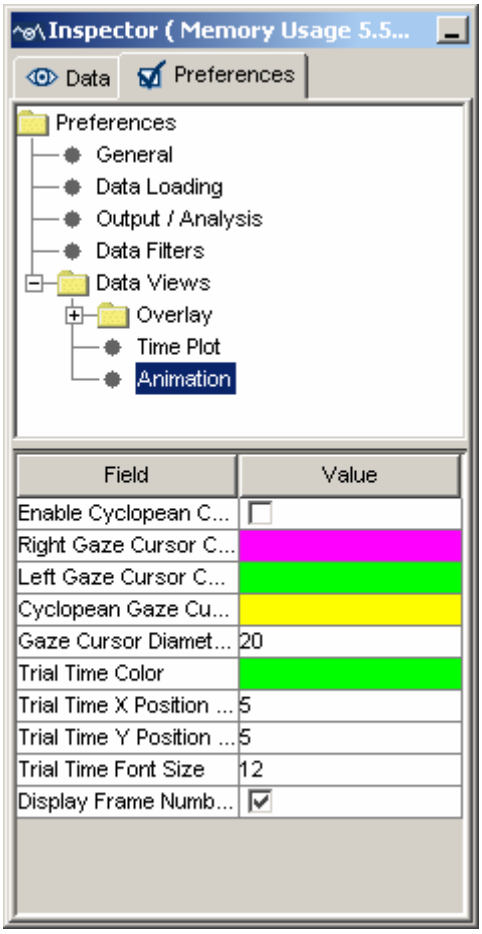
X Trace Highlighted, Y Trace Highlighted, and **Pupil Trace Highlighted**: Whether or not by default the X trace, y trace, and pupil trace are highlighted;

Initial Visible Sample Count: Total number of initially visible samples in the temporal graph view window (the default is 5000).

Use X Position for Fixation Location: If checked, use the X position to indicate the position of a fixation event in the temporal graph view; otherwise, use the Y position.

9.9 Animation Preferences

The parameters related to the animation playback preference settings are covered below:



Enable Cyclopean Cursor: For a binocular recording, enabling this option will display a cyclopean gaze cursor (instead of two separate gaze cursors) in the animation view.

Right Gaze Cursor Color, Left Gaze Cursor Color, Cyclopean Gaze Cursor: Set the colors to be used to show the right, left, and cyclopean gaze cursor. The default settings can be changed by clicking the corresponding cell and choosing a color from the palette or entering the value in RGB or HSB scales;

Gaze Cursor Diameter: Sets the diameter of the gaze cursor (in pixels);

Trial Time Color: Sets the color of the trial time code.

Trial Time X Position (%), Trial Time Y Position (%): Sets the x (percent of screen width) and y (percent of screen height) coordinates of the trial time code.

Trial Time Font Size: Sets the font size of the trial time code.

Display Frame Number: If checked, displays the frame number of the video being played.